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PROGRESS REPORT 2 - SUMMARY

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PROGRESS REPORT 2 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

The Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana) is presenting its second summary progress report for Tract C-a to the U.S.G.S. Area Oil Shale Supervisor (AOSS). This report covers the work accomplished from the period of October 1, 1974 through February 28, 1975. As requested by the Area Oil Shale Supervisor, the data collected from the Geotechnical Data Gathering Project and the Environmental Baseline Data Gathering Project are on file in the AOSS office in Grand Junction, Colorado. These data comprise Progress Report #2. This summary report presents an overview and highlights of these data. As requested, it has been correlated to and is organized consistent with Progress Report #2.

In the areas of study that have been undertaken during this reporting period, generalized descriptions are given of each study task's objectives and methods. Detailed descriptions of these areas will be on file with the progress report in the Area Oil Shale Supervisor's office.

It is also Rio Blanco's desire to keep the AOSS informed of its plans and position during the course of developing information for the Detailed Development Plan (DDP). In this context, although not required for inclusion in these summary progress reports, Rio Blanco Oil Shale Project is presenting as an appendix in this report a complete overview of the project. This overview is intended to show the relationship of the Geotechnical and Environmental Baseline Data Gathering Projects to the total scope of the Rio Blanco Oil Shale Project, and to describe all the areas being studied to develop the necessary information for the DDP and the final design of an oil shale facility.

Figure 1 is a Work Breakdown Structure Chart for the Rio Blanco Oil Shale Project. The project is broken down into its major subprojects and each subproject is divided into major study programs. The study programs are broken down into study tasks that are manageable in terms of planning and control. Examples of this detailed breakdown will be shown for the Geotechnical and Environmental Baseline Data Gathering Projects. The overview of the engineering studies includes a description of the many alternatives to be studied before developing a major oil shale mine and processing plant including the necessary ancillary facilities. The initial facility is planned to have an output rate of 50,000 barrels per stream day of synthetic crude oil.

Figure 2 is a location map of Tract C-a. The map includes major drainages, roads, towns and counties in the vicinity of the Tract.

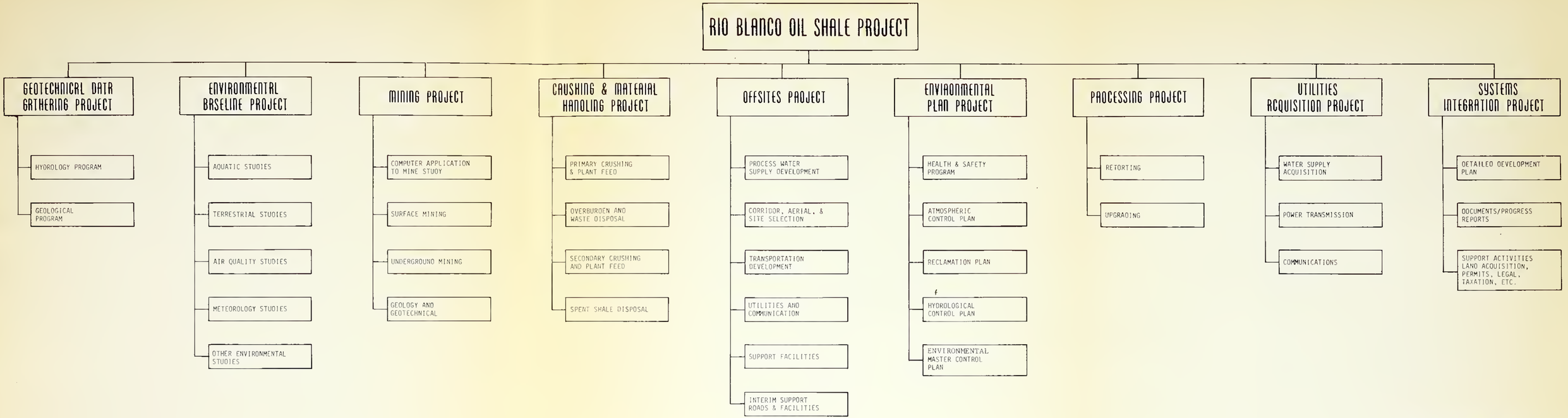
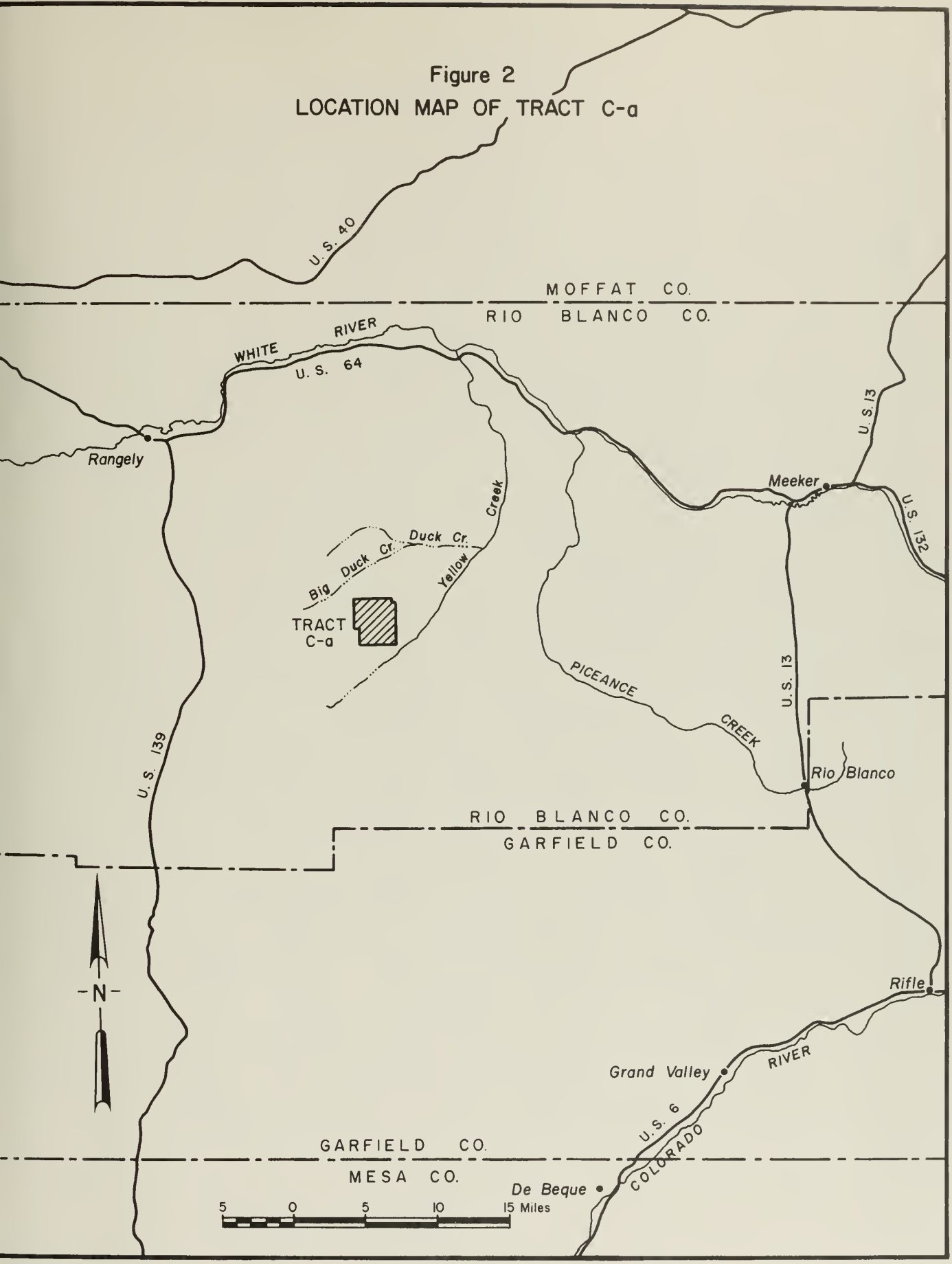


FIGURE - 1

WORK BREAKDOWN STRUCTURE FOR THE RIO BLANCO OIL SHALE PROJECT

Figure 2
LOCATION MAP OF TRACT C-a



1.0 GEOTECHNICAL DATA GATHERING PROJECT

The Geotechnical Data Gathering Project was designed to obtain data needed for engineering studies and development of Tract C-a. In undertaking this program, Rio Blanco Oil Shale Project subdivided the work into two portions: the Geologic Program, and the Hydrologic Program. Figure 1-1 is a work breakdown structure of the Geotechnical Data Gathering Project. The separate tasks are discussed in the summary that follows for each of the two major parts of the program. The work was performed by various contractors, under the supervision of Rio Blanco.

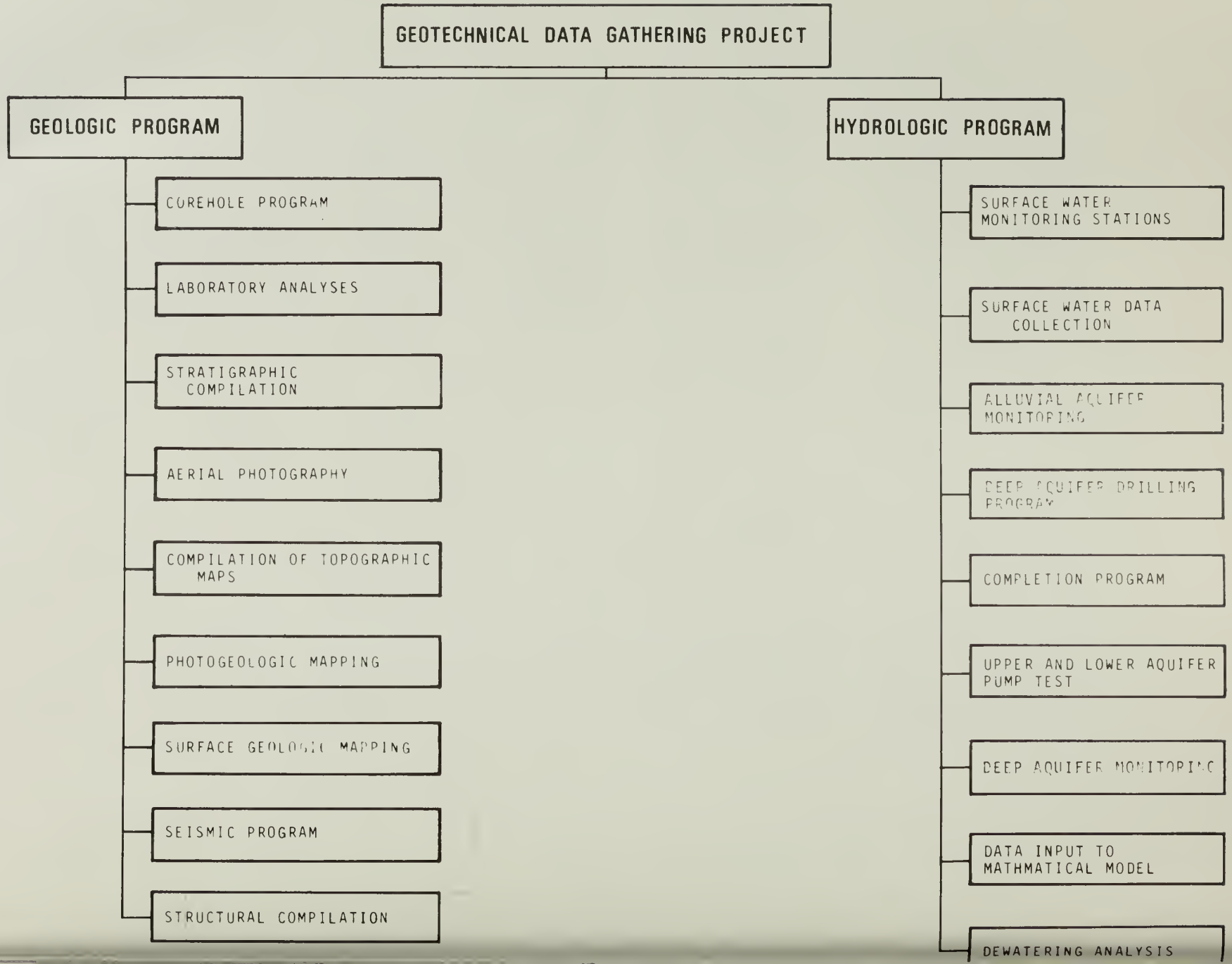
1.1 Geologic Program

The geologic program conducted by Rio Blanco Oil Shale Project is designed to provide the detailed structural, stratigraphic and resource data essential to the formulation of the Detailed Development Plan for Tract C-a. In order to effectively accomplish these objectives, the geologic program was separated into the nine tasks listed below with the appropriate prime contractor(s):

. Corehole Program -	Carmack Drilling Co. Dreiling Drilling Co. Amuedo & Ivey Schlumberger Birdwell
. Laboratory Analyses -	Core Laboratories
. Stratigraphic Compilation -	Amuedo & Ivey
. Aerial Photography -	Limbaugh Engineers, Inc.
. Compilation of Topographic Maps -	Limbaugh Engineers, Inc.
. Photogeologic Mapping -	Trollinger and Associates
. Surface Geologic Mapping -	Amuedo & Ivey
. Seismic Program -	Petroleum Geophysical, Inc.
. Structural Compilation -	Amuedo & Ivey

Figure 1-2, the functional flow-diagram for the geologic program, shows the relationship and the logic for the nine tasks. Several of the tasks were performed concurrently; most of the tasks are either finished or nearly completed. The raw

Figure 1-1


GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
STRUCTURAL COMPILATION
HYDROLOGIC PROGRAM
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DEEP AQUIFER MONITORING
DATA INPUT TO MATHMATICAL MODEL
DEWATERING ANALYSIS

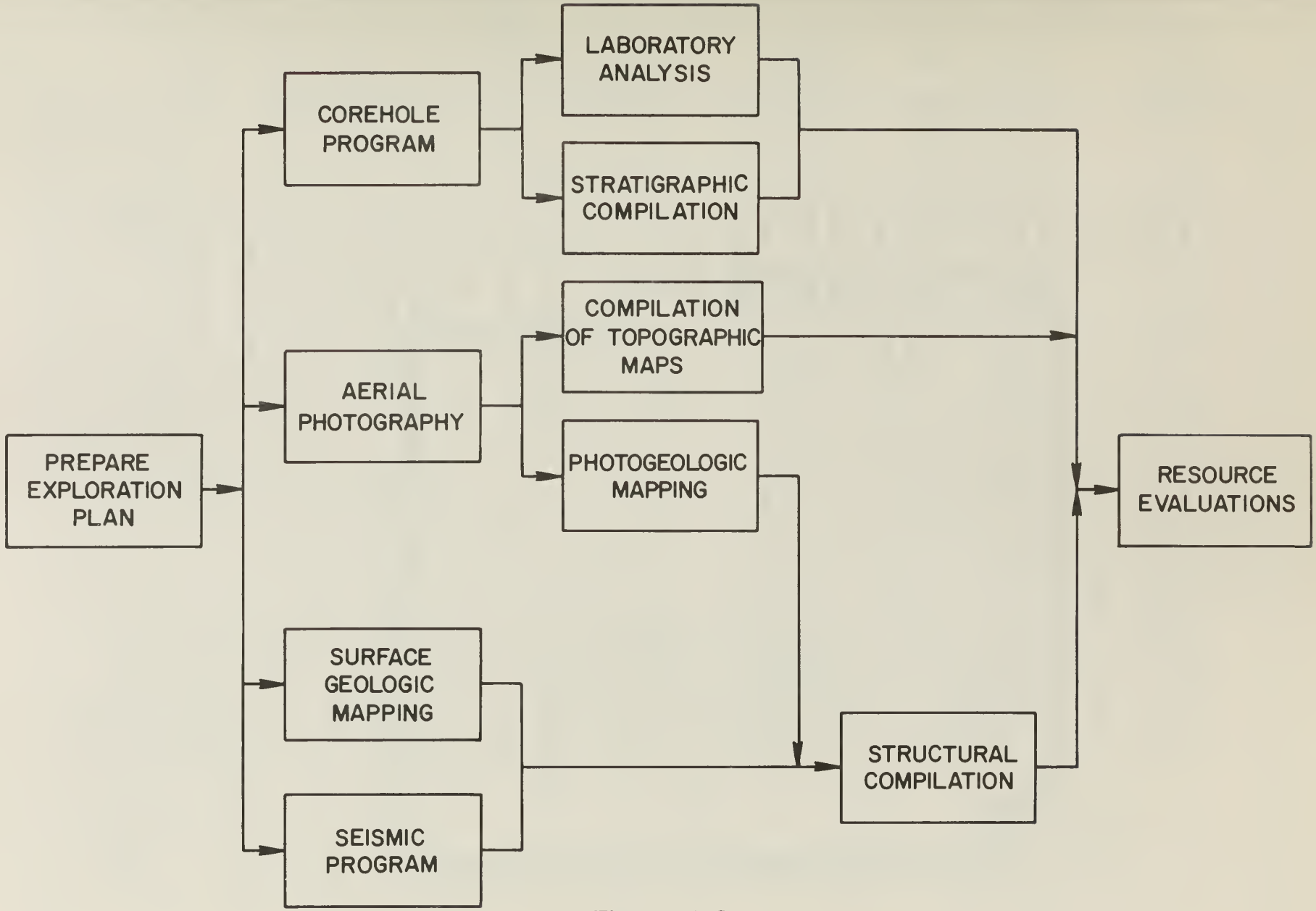


Figure 1-2

GEOLOGIC PROGRAM FUNCTIONAL FLOW DIAGRAM

data which have been submitted to the Area Oil Shale Supervisor in compliance with the oil shale lease is presented in Table 1-1. The specific tasks of the geologic program are summarized on the following pages.

1.1.1 Corehole Program

The corehole program was conducted in order to obtain samples from the oil shale resource from which data required for engineering studies could be determined. The program began on July 3, 1974 and was finished October 27, 1974, with the completion of thirteen coreholes. Fifteen coreholes were first proposed in the approved Exploratory Plan, however, two of the original corehole locations were dropped from the program for technical and environmental reasons.

Figure 1-3 is a map of Tract C-a showing the thirteen recent Rio Blanco coreholes, as well as the twelve pre-lease coreholes and the one pre-lease rotary drilled hole. Figure 1-4 is an example of the survey plats of the coreholes which have been submitted to the Area Oil Shale Supervisor as indicated in Table 1-1.

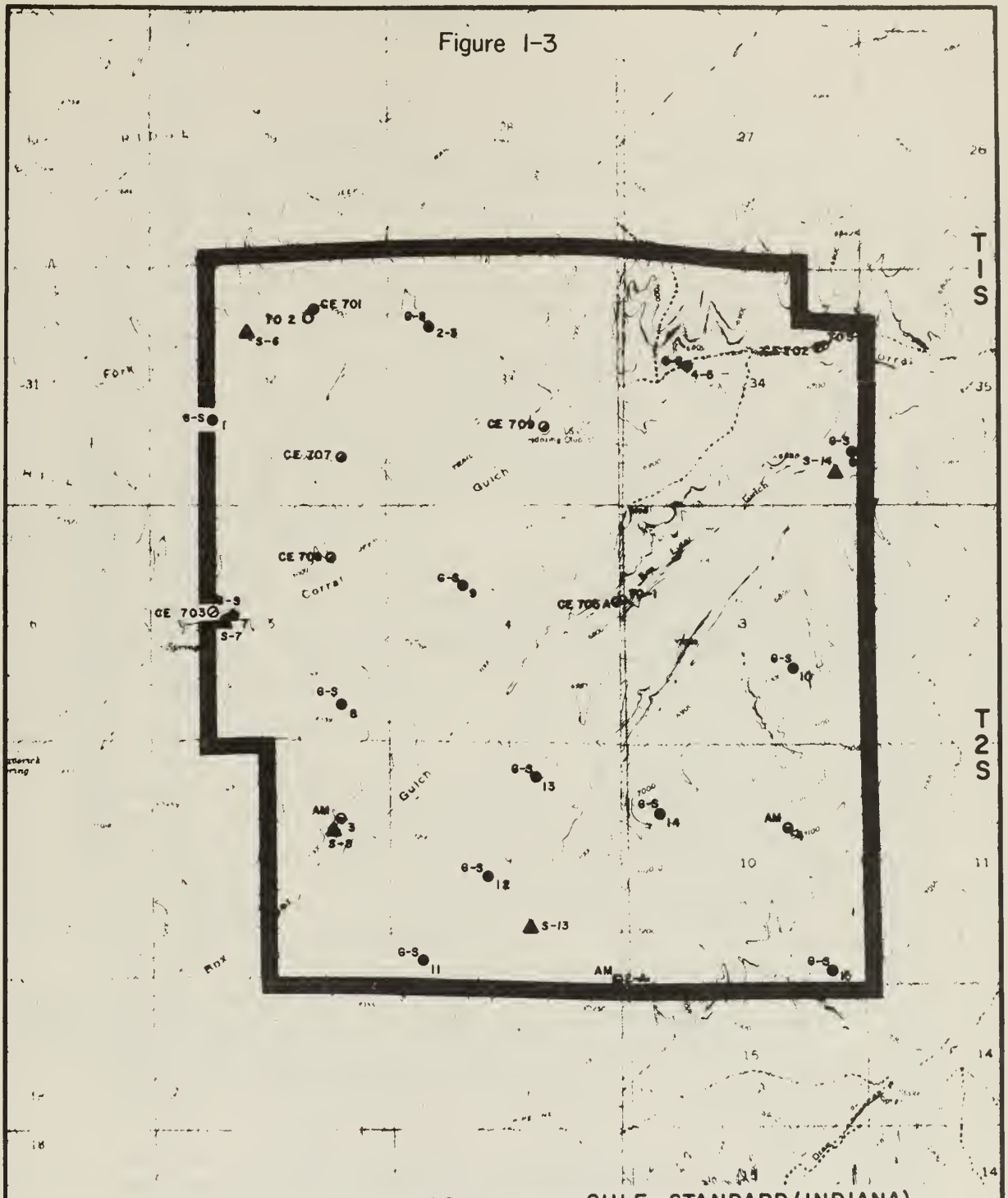
A tabulation of Gulf-Standard (Indiana) corehole information is presented in Table 1-2. Approximately 21,656 feet of hole was drilled of which 19,844.6 feet was core drilled. Core recovery ranged from 98.9% to 87.2%, in Rio Blanco coreholes #7 and #9, respectively. The average core recovery for the program was 93.3%. Lower core recovery, such as that in G-S 9 and G-S 12, appeared to be the result of core drilling in the proximity of fault zones where the oil shale was highly fractured.

The lithologic, as well as structural, description of the core was compiled by Amuedo and Ivey, the geologic contractor. A quantitative evaluation of the rock quality, termed Rock Quality Designation (RQD), was conducted by Amuedo and Ivey before the core was boxed. The RQD method is described in "Engineering Classification of In Situ Rock:" AFWL-TR-67-144, Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, 1969 by D. U. Deere, A. H. Merritt, and R. F. Coon. The lithologic strip logs including RQD were submitted to the Area Oil Shale Supervisor as is shown on Table 1-1.

Geophysical logs were run following the completion of each of the coreholes. The type of logs run and submitted to the Area Oil Shale Supervisor is presented on Table 1-1.

1.1.2 Laboratory Analyses

Figure 1-3



GULF - STANDARD (INDIANA)

TRACT C-a

RIO BLANCO OIL SHALE PROJECT

COREHOLE PROGRAM

SCALE: 1" = 3000'

PRE - SALE CORE HOLES

CE ⊘ CAMERON

TO ○ TOSCO

AM ● AMOCO PRODUCTION COMPANY

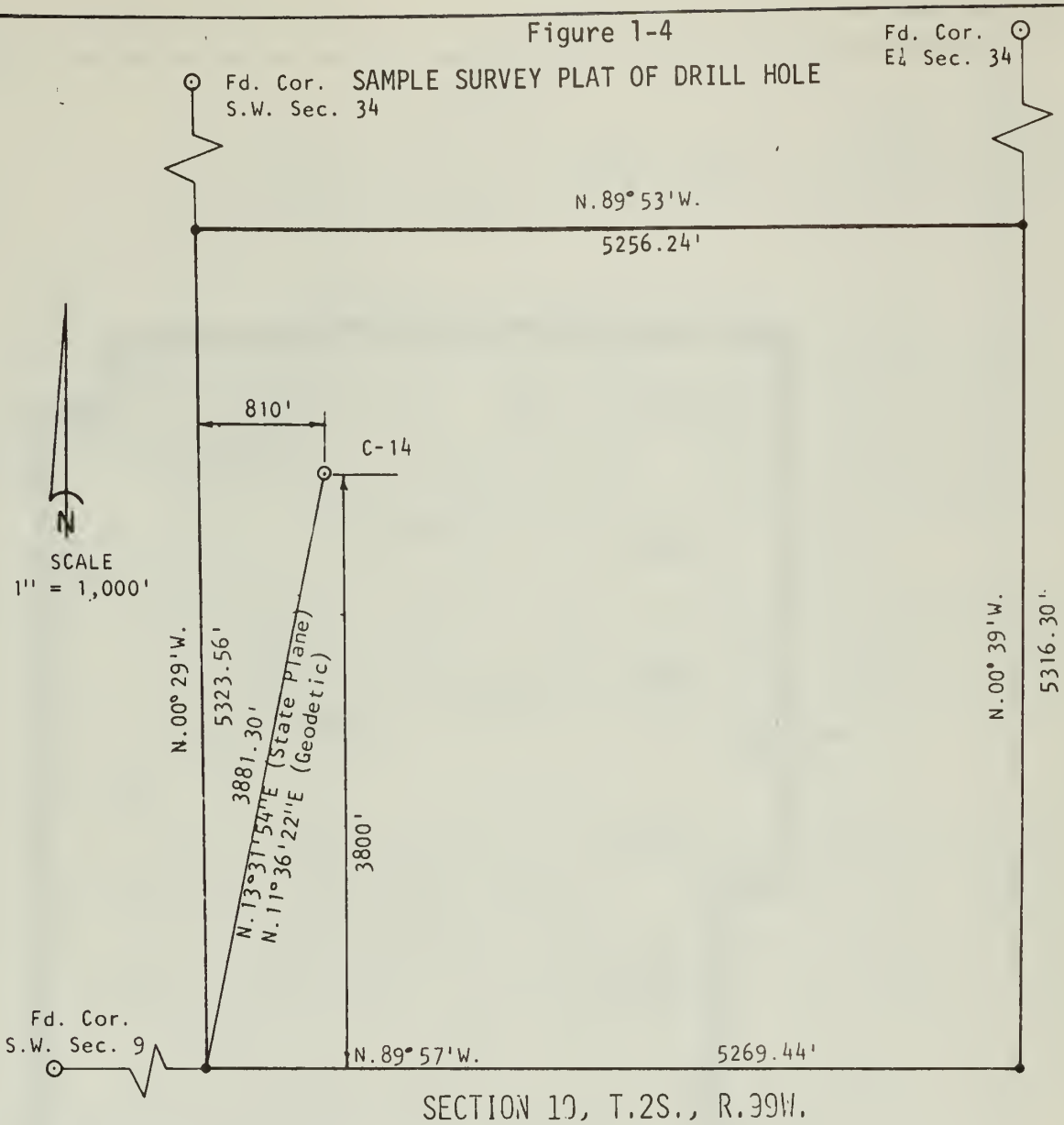
POST SALE CORE HOLES

G-S ● GULF - STANDARD

S-6 ▲ ALLUVIAL AQUIFER TEST WELL

Figure 1-4

SAMPLE SURVEY PLAT OF DRILL HOLE



SECTION 10, T.2S., R.99W.

LOCATION: DRILL HOLE C-14

NOTES: 1) DIMENSIONS AND BEARINGS OF SECTION LINES ARE FROM BLM RESURVEY OF 1944 AS RELATED TO FOUND CORNERS IN ADJACENT SECTIONS AND ARE ASSUMED TO BE BASED ON TRUE NORTH.
2) FIELD LOCATION ACCOMPLISHED SEPT. 4, 1974.

MILFORD J. COOLBAUGH, LS 10871

RIO BLANCO OIL SHALE PROJECT
DRILL HOLE LOCATION

DATE: OCTOBER 10, 1974	McDOWELL-SMITH & ASSOCIATES
PROJ: R7442	CONSULTING ENGINEERS — RIFLE, CO.

TABLE 1-1

DATA TRANSMITTED TO AREA OIL SHALE SUPERVISOR
GULF-STANDARD DRILLING PROGRAM TRACT C-A

	COREHOLES													MONITOR HOLES				DEEP AQUIFER HOLES			
	1	2-3	4-5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	16	17	18	19
Geophysical Logs																					
Schlumberger																					
Dual Ind. Laterolog	0	0		0	0	0															
Comp. Neutron Formation Density	0	0		0	0	0															
Borehole Comp. Sonic-Gamma Ray		0		0	0	0															
Engineered Production (Spinner-Temp)				0		0															
Continuous Directional						0															
Birdwell																					
Electric			0				0	X	X	0	X	X	X	X	X	X	X				
Gamma Ray Density-Neutron							0			0											
3-Dimensional Velocity	0		0				0	X	X	0	X	X	X	X	X	X	X				X
Temperature	0	0	0				0	X	X	0	X	X	X	X	X	X	X				
Spinner	0	0	0				0	X	X	0	X	X	X	X	X	X	X				
Caliper (Only)	0		0																		
Seisviewer		0			0		X	X	X	X		X	X					X	X	X	X
Nuclear = GR-Neutron			0					X	X		X	X	X	X	X	X	X				
Density	0		0																		
Gamma Ray Density								X	X		X	X	X	X	X	X	X	X	X	X	X
Continuous Directional Inclinometer													X								
Amuedo & Ivey Lithologic Rock Structure Logs	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X				
Core Lab Assays--Analyses																					
Fischer - G/T Oil	X	X	X	X	0	X	X	X	X	X		X	X								
Nahcolite	X	-	X	X	X	X	X	X	X	X		X	X								
Extractable Alumina	X	X	X	-	X	-	X	X	X	-	-	-	X								
Trace Elements	X	X	X	-	X	-	X	X	X	-	-	-	X								
McDowell-Smith Survey Plats - Elevations	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	0			

0 = Data Submitted To Area Oil Shale Supervisor as of September 30, 1974

X = Data Submitted To Area Oil Shale Supervisor as of February 28, 1975

TABLE 1-2
RIO BLANCO OIL SHALE PROJECT
GULF-STANDARD COREHOLE INFORMATION

HOLE NO.	DATE SPUDDED	DATE COMPLETE	LOCATION	ELEVATION KB[1]	ELEVATION G.S.[2]	TOTAL DEPTH (FT.)	FOOTAGE CORE DRILLED	PERCENTAGE (%) CORE RECOVERY
G-S 1	8/13/74	8/27/74	1490' FSL, 1280' FWL Sec. 32, T. 1 S., R. 99 W.	7254'	7248'	1404	1360.7	96.8
G-S 2-3	7/27/74	8/10/74	3810' FSL, 840' FWL Sec. 33, T. 1 S., R. 99 W.	6882'	6876'	1424	1352.5	91.7
G-S 4-5	8/11/74	9/ 3/74	3106' FSL, 1329' FWL Sec. 34, T. 1 S., R. 99 W.	6728'	6717'	1663	1615.5	92.0
G-S 6	7/ 2/74	7/26/74	1050' FSL, 110' FEL Sec. 34, T. 1 S., R. 99 W.	6665'	6658'	1781	1624.5	96.3
G-S 7	7/23/74	8/ 8/74	2650' FSL, 1850' FWL Sec. 5, T. 2 S., R. 99 W.	6995'	6984'	1200	1159.7	98.9
G-S 8	7/ 4/74	7/20/74	950' FSL, 950' FEL Sec. 5, T. 2 S., R. 99 W.	7279'	7268'	1616	1548.2	94.2
G-S 9	8/28/74	9/13/74	1805' FNL, 3520' FEL Sec. 4, T. 2 S., R. 99 W.	7138'	7131'	1600	1556.4	87.2
G-S 10	9/15/74	10/ 2/74	3630' FNL, 3795' FWL Sec. 3, T. 2 S., R. 99 W.	7013'	7006'	1902	1549.6	93.9
G-S 11	9/30/74	10/13/74	600' FSL, 780' FWL Sec. 9, T. 2 S., R. 99 W.	7351'	7340'	1886	1495.8	93.9
G-S 12	9/ 4/74	9/17/74	2300' FSL, 2125' FWL Sec. 9, T. 2 S., R. 99 W.	7277'	7266'	1800	1759.0	90.3
G-S 13	9/17/74	9/29/74	4530' FSL, 3220' FWL Sec. 9, T. 2 S., R. 99 W.	7202'	7191'	1751	1481.0	93.7
G-S 14	10/ 4/74	10/23/74	3800' FSL, 810' FWL Sec. 10, T. 2 S., R. 99 W.	7088'	7081'	1794	1546.6	91.9
G-S 15	10/14/74	10/30/74	400' FSL, 4450' FWL Sec. 10, T. 2 S., R. 99 W.	6991'	6980'	1835	1794.4	94.2
TOTALS						21656	19844.6	93.3 Avg.

1. KB is Kelly Bushing
2. G.S. is Ground Surface

1.1.2.1 Oil Shale Assays

Oil shale assays of the 3-1/2 inch core were by Modified Fischer assay (industry standard) to determine grade, which is expressed in gallons (shale oil) per ton of oil shale or GPT. Grade determination is the basis for the technical and economic engineering evaluations which are necessary inputs to the Detailed Development Plan.

Core Laboratories, Inc. conducted the analysis of the oil shale core, which is now complete with the exception of the entire core from G-S 13 and short core intervals in other holes held for rock mechanics tests. The Core Lab reports have been submitted to the Area Oil Shale Supervisor. Analysis of samples selected for rock mechanics tests are being completed after the rock mechanics work is finished. The core from G-S 13 has been withheld from Modified Fischer assay in case rock mechanics data or other analyses are required from that core.

1.1.2.2 Nahcolite Analyses

Nahcolite analyses were conducted to determine what concentrations of nahcolite may be expected from the mining of oil shale on Tract C-a. As the lithologic description of each core was being made, particular attention was paid to the location of occurrences of nahcolite in the core. Core Lab pulverized the designated two foot core samples containing nahcolite to pass a 100 mesh sieve and assayed the samples for nahcolite by the method described in U. S. Geological Survey Professional Paper #750B, pp. B194-P198, 1971 by John R. Dyni, Wayne Mountjoy, P. L. Hauff and Paul Blackman. The results of the analyses have been submitted to the Area Oil Shale Supervisor as shown by Table 1-1.

The data collected during the geologic program indicates that nahcolite will have little or no commercial potential under Tract C-a. This is due to the fact that the occurrences of nahcolite are rare, irregular, unpredictable and exist in very low concentrations within the oil shale sequence.

1.1.2.3 Extractable Alumina

Extractable alumina analyses were also conducted by Core Lab to determine what concentrations exist in the spent shale from the oil shale assays. The analyses were conducted on samples of spent shale which were composited from the Modified Fischer assays. The samples for the extractable alumina analyses were obtained from eight coreholes: G-S 1, G-S 2-3, G-S 4-5, G-S 7, G-S 9, G-S 10, G-S 11, and G-S 15. The sample intervals (not to exceed 100 feet) were chosen with respect to lithology

in that continuous two foot assay samples were composited to correlate with the alternating "rich zone - lean zone" (R-6, L-5, R-5, etc.) nomenclature. The method used by Core Lab for analysis of extractable alumina in spent shale was described in U. S. Bureau of Mines Report of Investigations #7286, August, 1969. All of the data from the analyses have been submitted to the Area Oil Shale Supervisor.

Engineering studies will be made to determine if the concentrations of extractable alumina in spent shale from Tract C-a indicate a potential for the economic recovery of alumina.

1.1.2.4 Trace Element Analyses

Trace element analyses in overburden and both fresh and spent shale have been completed for coreholes: G-S 1, G-S 2-3, G-S 4-5, G-S 7, G-S 9, G-S 10, G-S 11 and G-S 15. The data from the analyses has been submitted to the Area Oil Shale Supervisor. Rio Blanco Oil Shale Project has constructed histograms of the concentrations of each of the seven elements analyzed. These histograms have been submitted to the Area Oil Shale Supervisor in Volume 1.1.2 of this report. The sample interval for the trace element analyses is the same as that described for the extractable alumina analyses.

Table 1-3 is a summary of the maximum and minimum concentrations for each element as found in the samples from each particular corehole. The analytical procedures for the trace element analysis are described in the following references:

Fernandes, Frank J., "Analytical Chemistry", Vol. 12 #4 PP 93-97.
Ward, F. N. & Lakin, H.W., "Analytical Chemistry", Vol. 25, P. 1168.
M.E. Fleet, Anal. Chem., 39, 253-255 (1967).
Nakagawa, H.M., Harms, T.F.; U.S. Geological Survey Professional Paper #600-D, PP D207-D209, 1968.
Orion Specific Ion Meter Procedure Manual.
Ficklin, Walter H., U. S. Geological Survey Professional Paper #7000, PP. 186-188.
Hatch, W. R. and Ott, W. L., "Analytical Chemistry". #40 2085 (1968)
Perkin Elmer Mercury Analysis System Procedure Manual.

TABLE 1-3

MAXIMUM AND MINIMUM CONCENTRATIONS OF TRACE ELEMENTS
IN SPENT AND FRESH OIL SHALE FROM
GULF-STANDARD CORE DRILLING PROGRAM
(PPM)

Corehole Number		Cadmium		Antimony		Arsenic		Mercury		Selenium		Fluride Ion		Boron	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
G-S 1	Fresh	3.45	1.72	0.8	0.2	13.1	4.0	1.92	0.24	0.9	0.2	937	280	516	95
	Spent	3.33	1.46	0.6	0.1	12.3	1.0	1.89	0.19	1.1	0.2	846	64	269	31
G-S 2-3	Fresh	3.98	1.67	1.7	0.2	12.0	0.9	1.54	0.21	0.6	0.1	750	75	190	50
	Spent	2.95	1.56	1.0	0.1	9.8	0.7	1.75	**	0.8	0.1	790	75	150	*
G-S 4-5	Fresh	3.35	1.65	1.0	0.2	12.0	4.7	0.93	0.22	1.3	0.1	1315	152	311	14
	Spent	3.84	1.94	0.7	0.1	8.2	2.6	0.56	0.17	1.1	0.2	1217	79	185	6
G-S 7	Fresh	2.98	1.19	1.1	0.3	8.1	2.5	3.06	0.54	0.8	0.2	1300	140	160	59
	Spent	3.06	1.37	1.2	0.3	7.5	1.1	3.04	0.30	0.9	0.2	1100	140	140	37
G-S 9	Fresh	3.43	1.60	1.0	0.2	12.4	4.9	1.23	0.21	0.4	0.1	994	188	243	81
	Spent	3.87	1.85	0.6	0.1	15.7	1.5	1.26	0.05	0.5	0.1	779	84	329	5
G-S 10	Fresh	4.02	1.33	1.1	0.2	11.4	4.0	1.18	0.18	0.7	0.1	1068	178	242	39
	Spent	3.17	2.16	0.9	0.2	7.4	2.8	0.48	0.13	0.9	0.1	836	155	215	30
G-S 11	Fresh	3.12	0.84	1.2	0.1	11.4	4.2	1.65	0.13	0.9	0.1	968	131	344	88
	Spent	3.13	1.59	0.8	0.1	8.9	3.0	0.42	0.12	1.2	0.1	771	215	240	38
G-S 15	Fresh	3.56	1.31	1.3	0.2	15.1	2.2	1.17	0.11	1.0	0.1	1488	366	267	19
	Spent	3.37	1.35	1.2	0.1	12.4	1.0	0.72	0.08	1.0	0.3	1013	155	211	31

* Less than 0.5
** Less than 0.01

1.1.2.5 Gas Samples

Gas Samples were collected during the drilling of all thirteen coreholes in order to determine if gas may be a problem in underground mining methods. The samples were generally taken when the "A Groove" was penetrated, when the "B Groove" was penetrated and also at total depth. The sampling methods used were inadequate and other means of testing will have to be used to predict the possibility of gas in the formation.

During early exploration on and around Tract C-a, the distinctive odor of hydrogen sulfide was detected. During the Gulf-Standard drilling, the concentration of hydrogen sulfide was monitored with on-site detectors in coreholes G-S 11, G-S 14, and G-S 15. The holes drilled for the lower aquifer pump testing (described in Hydrologic Program), D-16, D-17, D-18, and D-19 were also monitored with the

on-site hydrogen sulfide detectors.. The maximum concentration of hydrogen sulfide from any of the holes monitored was 2.3 ppm.

1.1.2.6 Rock Mechanics

Rock Mechanics studies are included as part of the geologic program in order to determine the critical physical properties of the rock mass which could affect the stability of proposed mine openings.

The Rock Mechanics program for Tract C-a has been designed to be broad enough in scope to cover the range of probable mining methods, yet detailed enough to cover the range of possible mechanical properties of the rock en mass. This program can be divided into four parts: (1) gathering geotechnical data in the field, (2) conducting laboratory and in situ tests to determine the mechanical properties of the rock and rock mass, (3) developing reliable stability evaluation procedures, and (4) applying these procedures to proposed mine designs in order to quantitatively assess their stability. The program is designed to evaluate the stability of a number of different mining methods, including various room-and-pillar and open pit mine configurations. It is constructed to first provide Rio Blanco with general design parameters based on average mechanical properties of the rock mass and then with refined mine designs based on the range of structural properties found to exist in the rock mass within specific mining zones and areas.

The testing program consists of conducting laboratory tests and then analyzing the data developed during the course of the testing program. The purpose of this program is to determine the correct mechanical properties to use in the mine design. The type of tests which are being conducted are uniaxial and triaxial compression tests, indirect tensile tests, direct and indirect shear tests, dynamic and static elastic moduli laboratory tests, dynamic in situ elastic moduli tests, and defect analysis tests.

The following different stability evaluation procedures are being used: finite element modules, equilibrium analysis, tributary theory, and beam design. These design procedures are complementary. The Mohr-Coulomb theory is the basic failure theory being used in the mine design.

Rio Blanco is currently in the process of applying these procedures to test the stability of several of the proposed mine designs. Based on a detailed analysis of these results, decisions can be made as to the most appropriate mining system to be used for mining oil shale.

1.1.3 Stratigraphic Compilation

The evaluation of an oil shale resource requires the determination of the extent, thickness, and grade (gpt modified Fischer assay) of oil shales of potentially economic value. The beds of oil shale in the Green River Formations of Colorado have a lateral continuity that is expressed over relatively large areas. Detailed study of the oil shale sequence of interest shows the resource to consist of interbedded rich and lean oil shales and further to exhibit zonation in that thick rich intervals alternate with lean or nearly barren intervals. Donnell and Cashion have described this zonation in U.S. Geological Survey OC-65. Mining and economic evaluations require that the rich and lean zones be defined in detail. By identifying multiple key stratigraphic markers and units that are common to each of the 25 coreholes drilled on Tract C-a and correlating those markers and units from corehole to corehole it is possible to define the resource stratigraphy. The lithologic descriptions and oil shale assays of the core, as well as the geophysical logs of the coreholes, were used to identify stratigraphic markers and units common to each of the 25 on-tract coreholes.

A correlation network within Tract C-a has been completed with the construction of six cross sections (4 east-west and 2 north-south) consisting of the gamma ray-density logs from all 25 on-tract coreholes. Six similar cross sections have also been constructed from histograms of the oil shale assay from the 25 on-tract coreholes to supplement the gamma ray-density log sections. The histogram sections help define the stratigraphic boundaries of the alternating rich and lean oil shale zones. The established correlation of stratigraphic horizons will permit detailed computer mineral inventory of the entire oil shale sequence as well as individual zones and beds. The six gamma ray-density log cross sections and the six oil shale assay histogram cross sections are submitted to the Area Oil Shale Supervisor in Sec. 1.1.3 of this Progress Report.

The correlation of stratigraphic horizons has also aided in the estimating of oil shale grade in intervals where core was not recovered during coring or where core has been withheld from assay for rock mechanics tests.

Histograms of the concentrations of nahcolite, extractable alumina, and trace elements have been constructed in order to determine where, stratigraphically, they may occur. From this data, conclusions may be drawn as to whether or not the particular mineral, compound, or element occurrence is strictly controlled by stratigraphy. The histograms of

nahcolite and extractable alumina are presented on the six oil shale assay histograms. The histograms of the occurrences of concentrations of trace elements are presented in Volume 1.1.2 as mentioned above.

1.1.4 Aerial Photography

Limbaugh Engineers, Inc. has completed color and color-infrared aerial photography covering approximately 390 square miles. The new photo coverage has provided base control for the detailed environmental and mining studies as well as the stream drainage, access road, and facility locations that will be required for developmental planning.

The color coverage includes prints at a scale of 1"-1000' and 1"-3000'. The color-infrared coverage has been completed on prints at a scale of 1"-1000'. The photo indices have been completed and will be submitted to the Area Oil Shale Supervisor.

1.1.5 Compilation of Topographic Maps

Topographic mapping necessary for development of Tract C-a has been completed by Limbaugh Engineers, Inc. at a scale of one inch to 200 feet and one inch to 500 feet. The contour interval for both scales is 5 feet. Copies of the topographic maps have been submitted to the Area Oil Shale Supervisor.

1.1.6 Photogeologic Mapping

Trollinger and Associates have completed photogeologic mapping on 85 square miles. The tract area and vicinity comprise 81 square miles of this, with potential dam sites on Duck Creek and Yellow Creek comprising the additional four square miles. The photogeologic mapping formed the basis of detailed surface geological mapping.

1.1.7 Surface Geologic Mapping

Amuedo and Ivey have completed surface geologic mapping covering approximately 10 square miles. This area differs from the area covered by photogeologic mapping in that two square miles (Duck Creek dam site) were not included but five square miles at the Yellow Creek reservoir were added. The detailed surface mapping has delineated the faults, joints and fractures sufficiently so that mining plans can be formulated which will take into account the variance in structure of the oil shale within the Tract C-a boundary.

The map showing geologic features at the surface is submitted to the Area Oil Shale Supervisor in Sec. 1.1.7 of this Progress Report.

1.1.8 Seismic Program

The Exploratory Plan for Tract C-a contained a seismic program to help delineate structural features such as fault systems on the tract. This program called for about 10 miles of shallow high resolution reflection seismic lines.

The program was initiated with 200% coverage experimental shooting at four locations to determine optimum dynamite charge size, hole depth and geophone spread-spacing. The results were unsatisfactory, primarily because of near-surface noise effects. A second phase of experimental shooting consisting of 1-1/2 miles of continuous 600% coverage seismic line along Corral Gulch crossing known surface faults was run, again with unsatisfactory results, probably because of the same near-surface noise effects. Although the data will be reviewed further, the seismic program was discontinued by Rio Blanco due to its failure to delineate a reliable reflection within the oil shale sequence which would further define the fault systems within the tract.

1.1.9 Structural Compilation

As previously discussed, the definition of stratigraphic horizons are needed for computing the resource inventory. To produce a mining model, the resource inventory has to be corrected to attitude as well as for displacement due to faulting. Joints and fractures also affect the mine plan in that closely spaced joints or highly fractured areas possess a lower rock strength with the result of more costly mining due to lower recovery ratios and more expensive rock stability control programs. Compilation of the structural data obtained from the attitude of stratigraphic horizons, from subsurface structural data (core intersects with fault planes, etc.) from photogeologic mapping, and from surface geologic mapping will be incorporated into the mining model so that detailed mine programs can be developed and compared. The end product will then be the selection of the preferred mining plan for the development of the oil shale resource on Tract C-a.

The Structure Map - Middle "A Groove" shows the currently known structure within Tract C-a and is submitted to the Area Oil Shale Supervisor in Sec. 1.1.9 of this Progress Report.

1.2 Hydrologic Program

Rio Blanco Oil Shale Project is conducting the hydrologic program to provide the data for the following determinations: hydrologic, environmental baseline, aquifer characteristics and quality, and quantity of water expected to be produced from various mining plans. To accomplish these objectives, the program has been divided into the nine tasks listed below. Wright Water Engineers, Inc. of Denver, Colorado has been compiling the hydrologic data on behalf of Rio Blanco Oil Shale Project.

- Surface Water Monitoring
- Surface Water Data Collection
- Alluvial Aquifer Monitoring
- Deep Aquifer Drilling Program
- Completion Program
- Upper and Lower Aquifer Pump Testing
- Monitoring
- Data Input to Mathematical Model
- Dewatering Analysis

Figure 1-5 is a functional flow diagram of the hydrologic program.

The status or progress of each of the nine specific tasks is summarized on the following pages.

1.2.1 Surface Water Monitoring Stations

In order to establish an environmental baseline for the surface hydrology, the Rio Blanco Oil Shale Project has contracted with the Colorado River Water Conservation District to have the Water Resources Division of the U.S. Geological Survey (USGS) build and operate seven surface gaging stations. Six of the seven gaging stations have been continuously monitoring water flow since March, 1974. Specific conductance and temperature were monitored periodically from March, 1974, to November, 1974, at which time the six stations began continuously monitoring specific conductance and temperature. The seventh gaging station, located at the mouth of "Rinky Dink" Gulch, has been recording water flow data since November 1974. The location of each of the stations is shown on Figure 1-6. These stations consist of a weir built across the stream for measuring water flow rates. In addition to the flow rate, temperature and conductivity are continuously monitored by the use of automatic recording equipment. At periodic intervals water samples are collected and analyses are run for various chemical constituents as outlined by the Area Oil Shale Supervisor. Automatic sediment samplers have also been installed in order to collect data on the sediment load of the stream and have been in

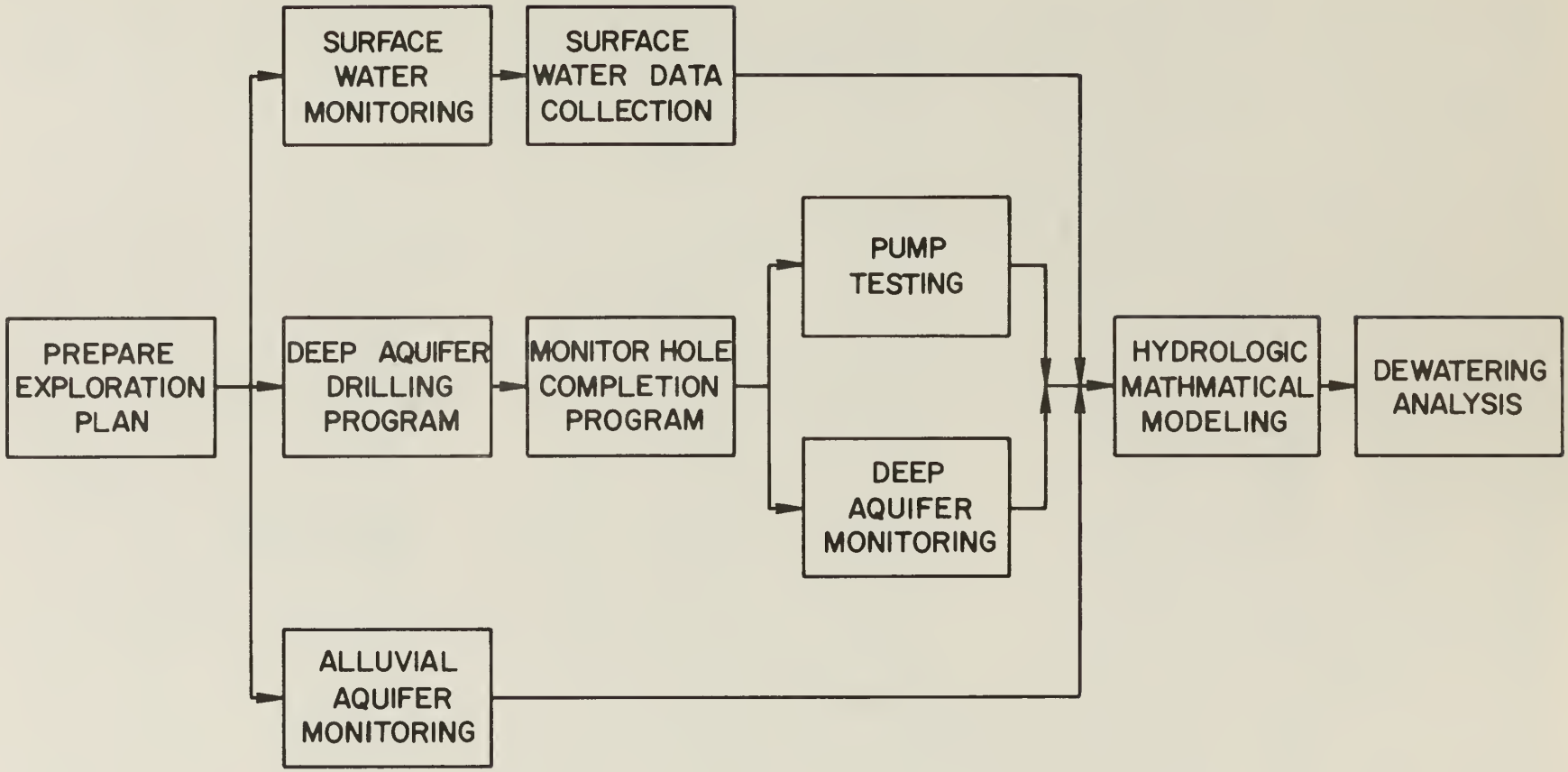


Figure 1-5

HYDROLOGIC PROGRAM FUNCTIONAL FLOW DIAGRAM

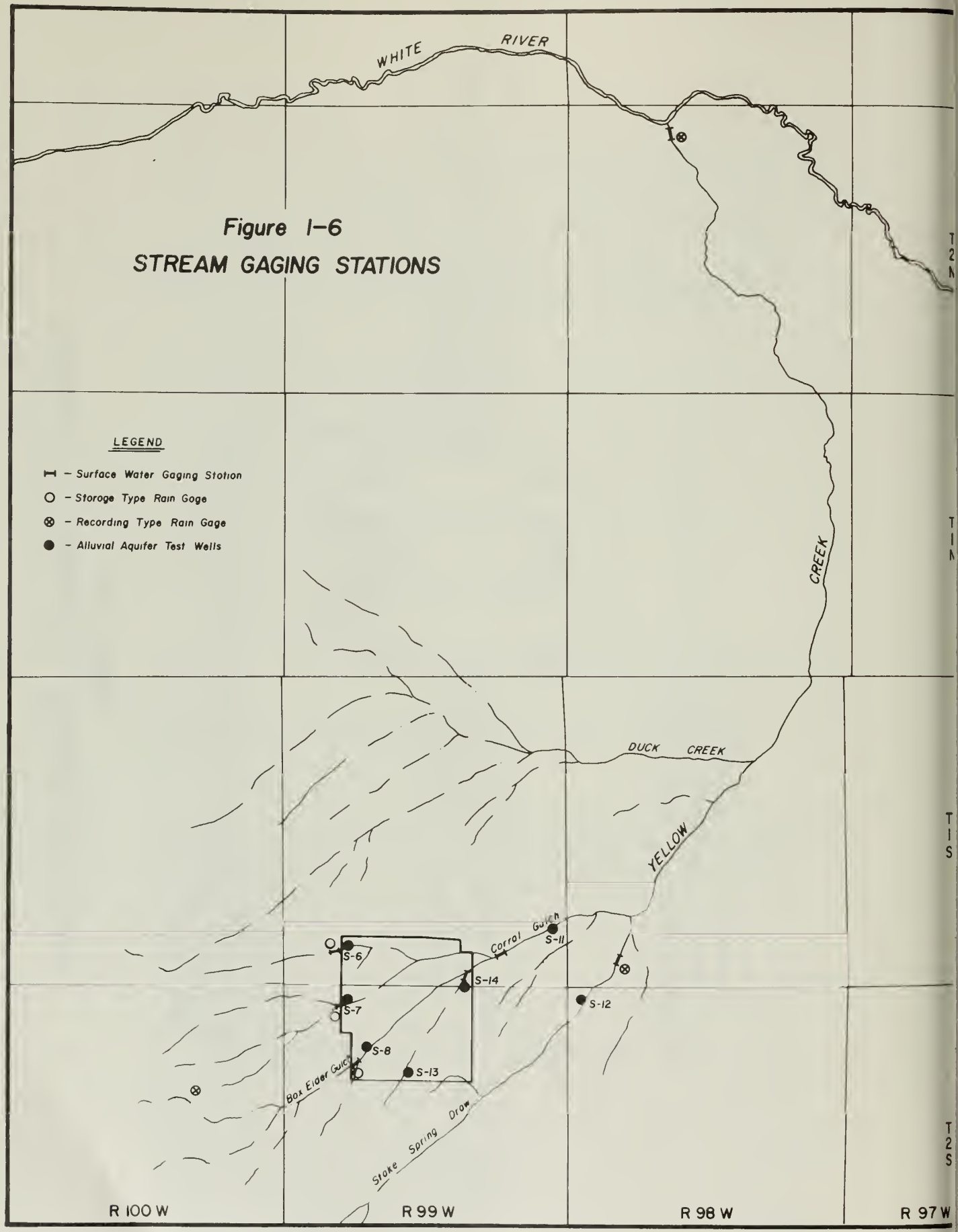


Figure 1-6
STREAM GAGING STATIONS

operation since August, 1974. Where there are relatively steady stream flows, the samplers are programmed to take samples at regualr intervals. In the cases where there are intermittent stream flows, the samplers are programmed to collect sediment samples every two minutes during a runoff event. Three of the seven gaging stations, Dry Fork, Stake Springs Draw and "Rinky Dink Gulch" have not shown any significant flow since installation.

The USGS has installed six rain gaging stations in addition to the surface gaging stations. The rain gaging stations are also shown on Figure 1-6. Three of these stations are of the storage type gages; precipitation is collected and hand measured at regular intervals. The remaining three rain gages are of the recording type in that a precipitation rate, for example, inches per hour, can be monitored. Table 1-4 shows the U.S. Geological Survey identification number for the various stream and rain gages.

1.2.2 Surface Water Data Collection

The first surface water data was collected on March 14, 1974, consisting of water flow records. Conductivity and temperature have been moritored continuously, from November 1974 to the present. Table 1-5 shows the data being collected and at what interval for each of the seven surface water gaging stations.

Table 1-6 is a sample print-out showing a portion of the data collected by the USGS from the Corral Gulch below Water Gulch gaging station. Figures 1-7 thru Figure 1-9 are plots of instantaneous discharge, specific conductance, boron, fluoride, arsenic, and lithium data taken from the USGS computer print-out.

The Area Oil Shale Supervisor receives, monthly, a copy of these print-outs from the U.S. Geological Survey - Water Resources Division.

1.2.3 Alluvial Aquifers

Most of the valley bottoms contain a variable thickness of alluvium. Drilling thus far has indicated thicknesses of 0 to 140 feet. In order to monitor and determine if water is present in this alluvium, seven alluvial monitor holes have been completed. A report on the drilling and completion of the seven alluvial aquifer holes has been submitted to the Area Oil Shale Supervisor.

The alluvial monitor holes are associated with surface gaging stations with the exception of the monitor hole located on "Rinky Dink Gulch" just north of the southern tract boundary. Figure 1-6 also shows the location of the seven alluvial monitor holes. Four of the seven holes drilled encountered water.

TABLE 1-4

LOCATION AND USGS IDENTIFICATION NUMBERS
FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification number	Location
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch below Water Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306200	Stake Springs Draw near confluence with Corral Gulch
09306250	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
	Rain Storage-Type Gages
09306235	Corral Gulch below Water Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	Recording Rain Gage
09306230	Stake Springs Draw near confluence with Corral Gulch
09306250	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW-1/4, NW-1/4, Sec.14, R100W T2S, R100W

TABLE 1-5

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

Flow Rate
Sediment Discharge
Temperature
Specific Conductance

Periodically

Storage Rain Gages
Recording Rain Gages

Semi-Monthly

Water Samples Analyzed For

Barium
Boron
Calcium
Chromium (Hexavalent)
Copper
Fluoride
Iron
Lithium
Magnesium
Potassium
Selenium
Silica
Sodium
Sulfate
Zinc
Ammonia
Bicarbonate
Carbonate
Chloride
Color
Dissolved Solids
Kjeldahl Nitrogen
Nitrate
Nitrite
Odor
Oil and Grease
Turbidity
Dissolved Oxygen
pH
Arsenic
Cadmium
Lead
Manganise
Mercury
Total Phosphate
Ortho Phosphate
Cyanide
Sulfide

Quarterly

Sample and Analyze

COD
Fecal Coliform
Pesticides
Polycyclic Aromatics
Radioactivity
Gross
4 curies/l
Ra^{226}
Gross
100 curies/l
Th^{230}
Uranium
Spectrographic Scan
67 Elements
TOC
10 mg/l
DOC
SOC
Phenols
Sulfur
Nitrogen

TABLE 1-6

WATER QUALITY DATA RECORDED AT THE CORRAL GULCH BELOW WATER GULCH GAGING STATION

PROCESS DATE 03/03/75

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	TIME	TYPE	SAMPLE NUMBER (00008)	TEMPERATURE (DEG C) (00010)	DISCHARGE (CFS) (00060)	INSTANTANEOUS DISCHARGE (CFS) (00061)	TURBIDITY (JTU) (00070)	COLOR (PLATINUM-COBALT UNITS) (00080)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKALINITY AS CACO3 (MG/L) (00410)
MAR., 1974												
14...	1130	2	--	4.5	.31	--	--	--	1060	7.9	7.6	311
25...	1300	2	--	9.0	.06	--	--	--	1100	7.8	10	326
APR.												
04...	1030	2	--	.5	--	.33	--	--	1110	8.1	5.4	350
19...	1050	2	--	8.0	--	.17	--	--	1100	7.9	7.8	317
27...	1000	2	--	7.5	--	1.1	--	--	1140	7.9	9.1	372
MAY												
03...	1215	2	--	18.0	--	.49	--	--	1090	8.0	6.6	338
17...	1050	2	1878	10.5	--	.79	--	--	1080	7.9	8.3	337
24...	1430	2	--	14.0	--	.58	--	--	--	--	--	--
30...	1255	2	--	22.5	--	.37	--	--	1050	7.9	7.2	291
JUNE												
13...	1100	2	--	21.0	--	.40	--	--	1070	8.0	6.1	311
21...	1215	2	--	24.0	--	.39	--	--	1070	8.1	4.8	309
27...	1400	2	--	27.5	.35	--	--	--	1070	8.0	5.9	301
JULY												
03...	0815	2	--	11.0	--	.29	--	--	1100	7.9	8.1	330
12...	1115	2	--	20.0	--	.24	--	--	1090	8.0	6.2	319
20...	--	2	--	13.0	--	.05	--	--	1080	7.8	9.9	321
AUG.												
02...	0950	2	--	13.0	--	.41	--	--	1100	7.9	8.1	328
10...	1750	2	--	18.0	--	.28	--	--	1110	8.0	6.5	331
31...	1100	2	--	17.5	--	.33	--	--	1100	--	--	315
SEP.												
13...	1030	2	--	10.0	--	.31	--	--	1100	--	--	325
26...	1230	2	--	11.0	--	.29	--	--	1090	--	--	304
OCT.												
03...	1400	2	--	12.5	--	--	--	--	1070	--	--	313
09...	1245	2	--	16.5	--	--	--	--	1050	--	--	299
16...	1020	2	--	7.0	--	.51	--	--	1080	--	--	311
24...	1245	2	--	14.0	--	.15	--	--	1070	--	--	305
NOV.												
01...	1230	2	--	7.5	--	.30	--	--	1090	--	--	320
15...	1330	2	--	6.0	--	.19	--	--	1090	7.7	12	317
JAN., 1975												
08...	1015	2	--	5.0	--	--	2	3	1150	8.1	6.5	421

TABLE 1-6 (continued)

PROCESS DATE 03/03/

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	BICARBONATE (HCO3) (MG/L) (00440)	CARBONATE (CO3) (MG/L) (00445)	OIL AND GREASE (MG/L) (00550)	DISSOLVED AMMONIA NITROGEN (N) (MG/L) (00608)	DISSOLVED NITRITE (N) (MG/L) (00613)	DISSOLVED NITRATE (N) (MG/L) (00618)	TOTAL KJELDAHL NITROGEN (N) (MG/L) (00625)	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)	DISSOLVED ORTHO PHOSPHATE (PO4) (MG/L) (00660)	TOTAL PHOSPHORUS (P) (MG/L) (00665)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L) (00671)	TOTAL ORGANIC CARBON (C) (MG/L) (00680)
MAR., 1974												
14...	379	0	--	--	--	--	--	1.1	.09	--	.03	--
25...	398	0	--	--	--	--	--	2.2	.09	--	.03	--
APR.												
04...	427	0	--	--	--	--	--	1.2	.09	--	.03	--
19...	386	0	--	--	--	--	--	1.0	.03	--	.01	--
27...	454	0	--	--	--	--	--	.95	.15	--	.05	--
MAY												
03...	412	0	--	--	--	--	--	1.8	.06	--	.02	--
17...	411	0	--	--	--	--	--	1.9	.00	--	.00	--
24...	--	--	--	--	--	--	--	1.8	.09	--	.03	--
30...	355	0	--	--	--	--	--	1.6	.06	--	.02	--
JUNE												
13...	379	0	--	--	--	--	--	1.3	.28	--	.09	--
21...	377	0	--	--	--	--	--	1.1	.03	--	.01	--
27...	367	0	--	--	--	--	--	.93	.03	--	.01	16
JULY												
03...	402	0	--	--	--	--	--	1.3	.00	--	.00	--
12...	389	0	--	--	--	--	--	1.1	.03	--	.01	--
20...	391	0	--	--	--	--	--	.90	.03	--	.01	--
AUG.												
02...	400	0	--	--	--	--	--	1.1	.00	--	.00	--
10...	404	0	--	--	--	--	--	1.3	.03	--	.01	--
31...	384	--	--	--	--	--	--	.83	.06	--	.02	--
SEP.												
13...	396	--	--	--	--	--	--	.78	.12	--	.04	--
26...	371	--	--	--	--	--	--	.72	.03	--	.01	--
OCT.												
03...	382	--	--	--	--	--	--	.01	.00	--	.00	--
09...	365	--	--	--	--	--	--	.69	.03	--	.01	--
16...	379	--	--	--	--	--	--	.81	.00	--	.00	--
24...	372	--	--	--	--	--	--	.71	.00	--	.00	--
NOV.												
01...	390	--	--	--	--	--	--	.81	.03	--	.01	--
13...	387	--	--	--	--	--	--	.82	.00	--	.00	--
JAN., 1975												
06...	513	0	9	.01	.00	.27	.31	.27	.00	.10	.00	--

TABLE 1-6 (Continued)

PROCESS DATE 03/03/7

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	CYANIDE (CN) (MG/L) (00720)	DIS-SOLVED SUL-FIDE (S) (MG/L) (00746)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD-SORP-TION RATIO (00931)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L) (00935)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)
MAR., 1974												
14...	--	--	440	130	85	55	84	1.7	29	1.3	7.4	280
25...	--	--	460	140	92	57	85	1.7	28	1.4	8.2	280
APR.												
04...	--	--	470	120	92	58	88	1.8	29	1.4	7.1	260
19...	--	--	470	160	90	60	88	1.8	29	1.2	8.0	320
27...	--	--	460	88	87	59	88	1.8	29	1.8	7.5	270
MAY												
03...	--	--	460	120	90	56	78	1.6	27	1.7	6.7	260
17...	--	--	480	140	97	57	74	1.5	25	1.2	5.7	260
24...	--	--	490	--	92	62	76	1.5	25	.9	6.9	270
30...	--	--	450	160	82	60	78	1.6	27	1.3	6.0	270
JUNE												
13...	--	--	450	140	84	59	86	1.8	29	1.1	7.0	290
21...	--	--	450	140	80	60	86	1.8	29	1.4	6.8	270
27...	--	--	440	140	80	59	85	1.8	29	1.5	7.3	290
JULY												
03...	--	--	500	170	96	62	83	1.6	27	1.1	6.7	270
12...	--	--	480	160	92	60	82	1.6	27	1.8	6.4	280
20...	--	--	500	180	99	62	84	1.6	27	1.4	8.3	290
AUG.												
02...	--	--	470	140	94	57	86	1.7	28	1.3	8.0	290
10...	--	--	450	120	88	57	86	1.8	29	1.6	8.2	290
31...	--	--	440	130	85	56	85	1.8	29	2.5	9.4	290
SEP.												
13...	--	--	440	120	62	70	84	1.7	29	2.8	9.5	280
26...	--	--	450	150	78	62	86	1.8	29	2.1	8.1	290
OCT.												
03...	--	--	410	93	72	55	89	1.9	32	.6	7.8	290
09...	--	--	390	93	68	54	89	2.0	33	.9	8.1	260
16...	--	--	440	130	88	54	89	1.8	30	1.4	7.2	280
24...	--	--	410	100	81	50	86	1.9	31	1.5	7.5	290
NOV.												
01...	--	--	430	110	86	53	88	1.8	31	1.5	7.5	270
13...	--	--	430	120	78	58	90	1.9	31	.7	7.3	280
JAN., 1975												
08...	.00	.1	510	85	92	67	120	2.3	34	1.6	9.5	310

TABLE 1-6 (Continued)

PROCESS DATE 03/03/

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BARIUM (BA) (UG/L) (01005)	DIS-SOLVED BERYL-LIUM (BE) (UG/L) (01010)	DIS-SOLVED BISMUTH (BI) (UG/L) (01015)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CAD-MIUM (CD) (UG/L) (01025)	DIS-SOLVED CHRO-MIUM (CR) (JG/L) (01030)	DIS-SOLVED COBALT (CO) (UG/L) (01035)	DIS-SOLVED COPPER (CU) (UG/L) (01040)	DIS-SOLVED IRON (FE) (UG/L) (01046)
MAR., 1974												
14...	.3	20	--	--	--	--	--	--	--	--	--	20
25...	.6	19	--	--	--	--	--	--	--	--	--	0
APR.												
04...	.8	19	1	--	--	--	--	1	--	--	--	20
19...	.3	22	23	--	--	--	--	3	--	--	--	80
27...	.9	24	--	--	--	--	--	--	--	--	--	250
MAY												
03...	1.5	24	--	--	--	--	--	--	--	--	--	60
17...	.7	23	9	120	<5	<10	80	2	<7	<14	5	140
24...	.3	24	2	0	--	--	90	1	--	--	3	20
30...	.3	24	4	200	--	--	110	1	--	--	4	10
JUNE												
13...	.3	22	5	200	--	--	100	2	--	--	10	190
21...	.2	22	4	0	--	--	100	1	--	--	2	20
27...	.2	18	4	<100	--	--	40	2	--	--	6	70
JULY												
03...	.2	21	8	<100	--	--	100	0	--	--	2	40
12...	.2	22	5	<100	--	--	120	3	--	--	6	100
20...	.2	13	3	0	--	--	80	2	--	--	14	80
AUG.												
02...	.2	23	4	0	--	--	100	<1	--	--	4	150
10...	.2	22	4	0	--	--	100	<1	--	--	7	120
31...	.2	22	2	0	--	--	110	<1	--	--	3	280
SEP.												
13...	.2	21	4	0	--	--	100	1	--	--	5	70
26...	.3	22	5	0	--	--	30	5	--	--	13	200
OCT.												
03...	.0	.2	1	0	--	--	100	<1	--	--	2	90
09...	.2	21	6	0	--	--	110	<1	--	--	3	100
16...	.2	21	8	<100	--	--	70	0	--	--	2	20
24...	.3	22	4	0	--	--	130	0	--	--	3	20
NOV.												
01...	.2	21	5	<100	--	--	60	0	--	--	1	50
13...	.2	19	6	0	--	--	90	0	--	--	1	30
JAN., 1975												
08...	.3	19	4	<100	--	--	120	0	0	--	1	10

TABLE 1-6 (Continued)

PROCESS DATE 03/03/75

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	DIS-SOLVED LEAD (PB) (UG/L) (01049)	DIS-SOLVED MANGANESE (MN) (UG/L) (01056)	DIS-SOLVED MOLYB-DENUM (MO) (UG/L) (01060)	DIS-SOLVED NICKEL (NI) (UG/L) (01065)	DIS-SOLVED SILVER (AG) (UG/L) (01075)	DIS-SOLVED STRON-TIUM (SR) (UG/L) (01080)	DIS-SOLVED VANA-DIUM (V) (UG/L) (01085)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)	DIS-SOLVED TIN (SN) (UG/L) (01100)	DIS-SOLVED ALUM-INUM (AL) (UG/L) (01106)	DIS-SOLVED GALLIUM (GA) (UG/L) (01120)	DIS-SOLVED GER-MANIUM (GE) (UG/L) (01125)
MAR.. 1974												
14...	--	0	--	--	--	--	--	--	--	--	--	--
25...	--	0	--	--	--	--	--	--	--	--	--	--
APR.												
04...	--	--	--	--	--	--	--	--	--	--	--	--
19...	--	0	--	--	--	--	--	--	--	--	--	--
27...	--	40	--	--	--	--	--	--	--	--	--	--
MAY												
03...	--	20	--	--	--	--	--	--	--	--	--	--
17...	<14	10	40	<7	<2	1500	<10	340	<10	220	<7	<14
24...	2	10	--	--	--	--	--	10	--	--	--	--
30...	2	0	--	--	--	--	--	20	--	--	--	--
JUNE												
13...	15	0	--	--	--	--	--	30	--	--	--	--
21...	5	0	--	--	--	--	--	10	--	--	--	--
27...	4	160	--	--	--	--	--	0	--	--	--	--
JULY												
03...	3	0	--	--	--	--	--	0	--	--	--	--
12...	7	20	--	--	--	--	--	20	--	--	--	--
20...	7	0	--	--	--	--	--	10	--	--	--	--
AUG.												
02...	3	10	--	--	--	--	--	10	--	--	--	--
10...	3	30	--	--	--	--	--	10	--	--	--	--
31...	4	0	--	--	--	--	--	10	--	--	--	--
SEP.												
13...	2	10	--	--	--	--	--	10	--	--	--	--
26...	3	0	--	--	--	--	--	0	--	--	--	--
OCT.												
03...	0	0	--	--	--	--	--	110	--	--	--	--
09...	230	10	--	--	--	--	--	410	--	--	--	--
16...	6	0	--	--	--	--	--	80	--	--	--	--
24...	3	0	--	--	--	--	--	10	--	--	--	--
NOV.												
01...	2	0	--	--	--	--	--	30	--	--	--	--
13...	0	0	--	--	--	--	--	10	--	--	--	--
JAN.. 1975												
08...	3	50	--	--	--	--	--	10	--	--	--	--

TABLE 1-6 (Continued)

PROCESS DATE 03/03/75

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	DIS-SOLVED LITHIUM (LI) (UG/L) (01130)	DIS-SOLVED SELE-NIUM (SE) (UG/L) (01145)	DIS-SOLVED TI-TANIUM (TI) (UG/L) (01150)	DIS-SOLVED ZIR-CONIUM (ZR) (UG/L) (01160)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	DIS-SOLVED SOLIDS (TONS PER AC-FT) (70303)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L) (70507)	DIS_SOLVED AMMONIA (NH4) (MG/L) (71846)
MAR., 1974									
14...	--	--	--	--	725	.61	.99	--	--
25...	--	--	--	--	749	.12	1.02	--	--
APR.									
04...	--	--	--	--	742	.66	1.01	--	--
19...	--	4	--	--	784	.36	1.07	--	--
27...	--	--	--	--	767	2.42	1.04	--	--
MAY									
03...	--	--	--	--	729	.96	.99	--	--
17...	14	7	9	<20	730	1.56	.99	--	--
24...	20	4	--	--	--	--	--	--	--
30...	20	8	--	--	704	.70	.96	--	--
JUNE									
13...	20	4	--	--	743	.80	1.01	--	--
21...	20	7	--	--	717	.76	.98	--	--
27...	20	5	--	--	726	.69	.99	--	--
JULY									
03...	0	5	--	--	744	.58	1.01	--	--
12...	0	5	--	--	741	.48	1.01	--	--
20...	10	1	--	--	755	.10	1.03	--	--
AUG.									
02...	0	4	--	--	762	.84	1.04	--	--
10...	0	2	--	--	758	.57	1.03	--	--
31...	0	4	--	--	744	.66	1.01	--	--
SEP.									
13...	10	2	--	--	729	.61	.99	--	--
26...	0	4	--	--	735	.58	1.00	--	--
OCT.									
03...	0	4	--	--	703	--	.96	--	--
09...	0	3	--	--	685	--	.93	--	--
16...	0	3	--	--	732	1.01	1.00	--	--
24...	10	6	--	--	725	.29	.99	--	--
NOV.									
01...	20	4	--	--	723	.59	.98	--	--
13...	0	3	--	--	728	.37	.99	--	--
JAN., 1975									
08...	10	3	--	--	874	--	1.19	.05	.01

TABLE 1-6 (Continued)

PROCESS DATE 03/03/75

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA

DATE	DIS_ SOLVED NITRATE (NO3) (MG/L) (71851)	DIS_ SOLVED NITRITE (NO2) (MG/L) (71856)	DIS- SOLVED MERCURY (HG) (UG/L) (71890)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE MSL) (72000)
MAR., 1974				
14...	--	--	--	6980
25...	--	--	--	6980
APR.				
04...	--	--	.0	6980
19...	--	--	--	6980
27...	--	--	--	6980
MAY				
03...	--	--	--	6980
17...	--	--	--	6980
24...	--	--	.0	6980
30...	--	--	.0	6980
JUNE				
13...	--	--	.0	6980
21...	--	--	.0	6980
27...	--	--	.1	6980
JULY				
03...	--	--	.1	6980
12...	--	--	.0	6980
20...	--	--	.0	6980
AUG.				
02...	--	--	.0	6980
10...	--	--	.0	6980
31...	--	--	.0	6980
SEP.				
13...	--	--	.5	6980
26...	--	--	.0	6980
OCT.				
03...	--	--	.0	6980
09...	--	--	.1	6980
16...	--	--	.0	6980
24...	--	--	.0	6980
NOV.				
01...	--	--	.0	6980
13...	--	--	.1	6980
JAN., 1975				
08...	1.2	.00	1.2	6980

Figure 1-7

SPECIFIC CONDUCTANCE AND INSTANTANEOUS DISCHARGE DATA
RECORDED AT THE CORRAL GULCH EAST OF TRACT C-a GAGING STATION

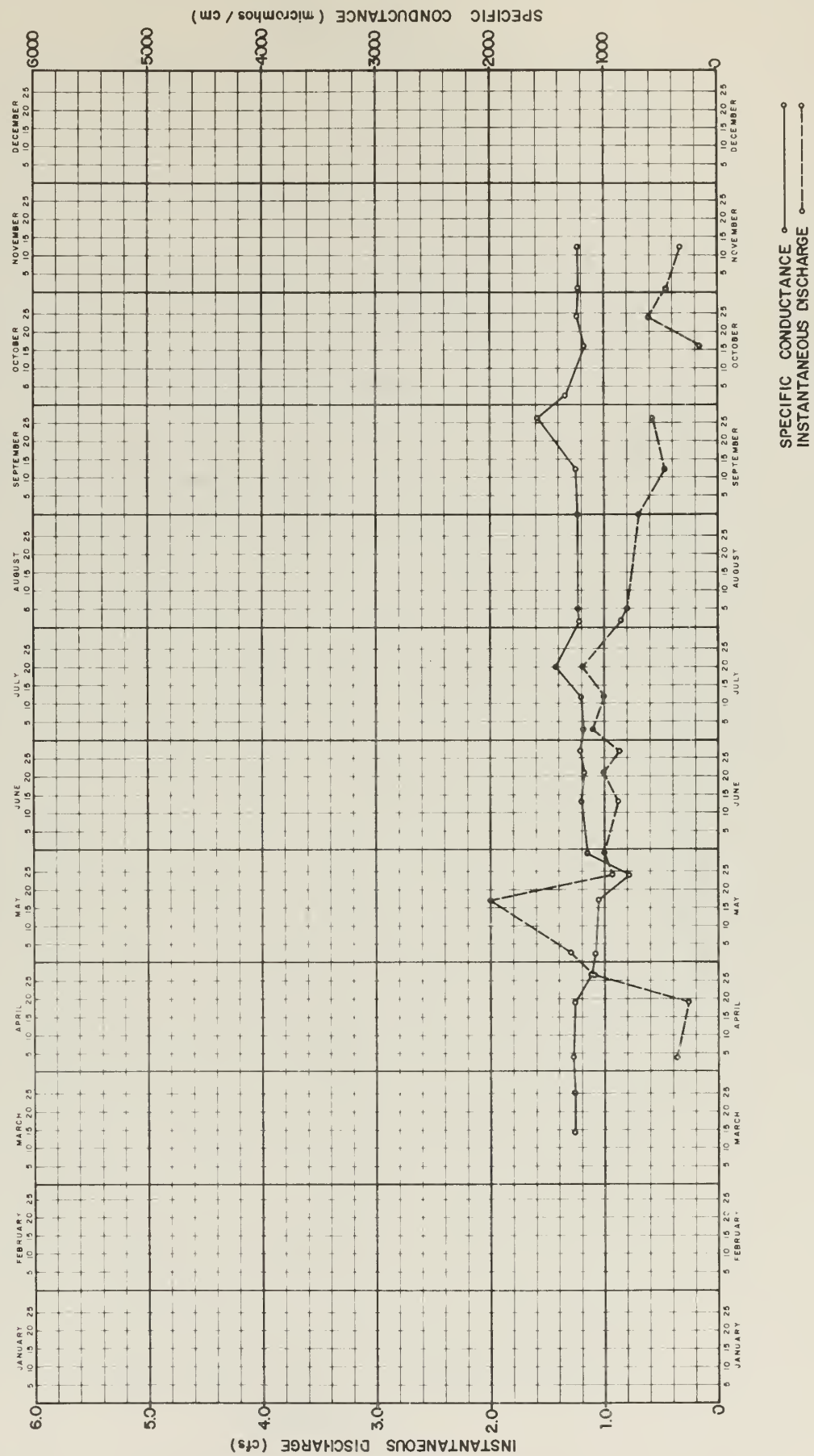


Figure 1-8

BORON AND FLUORIDE CONCENTRATIONS RECORDED AT
THE CORRAL GULCH EAST OF TRACT C-a GAGING STATION

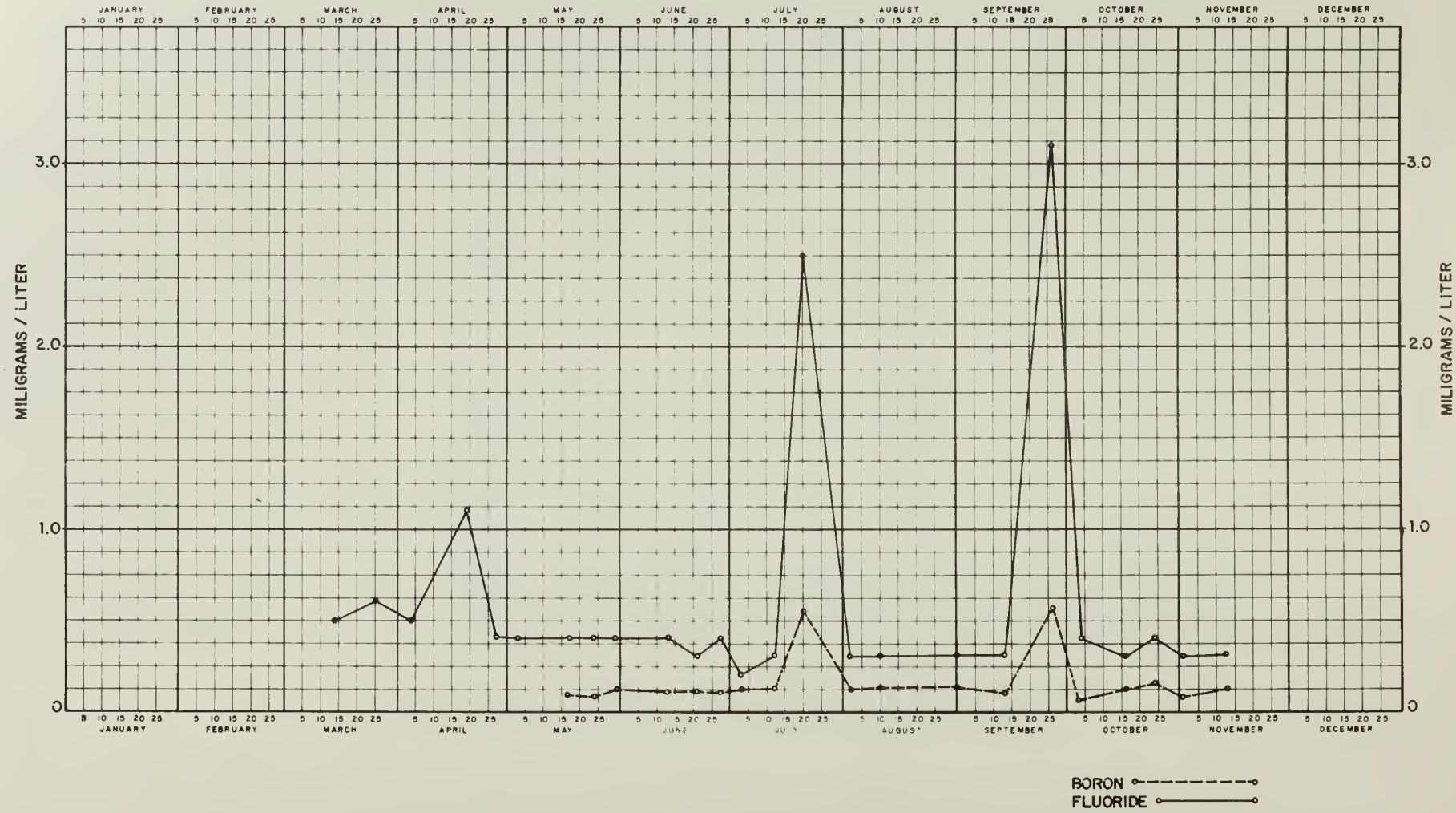
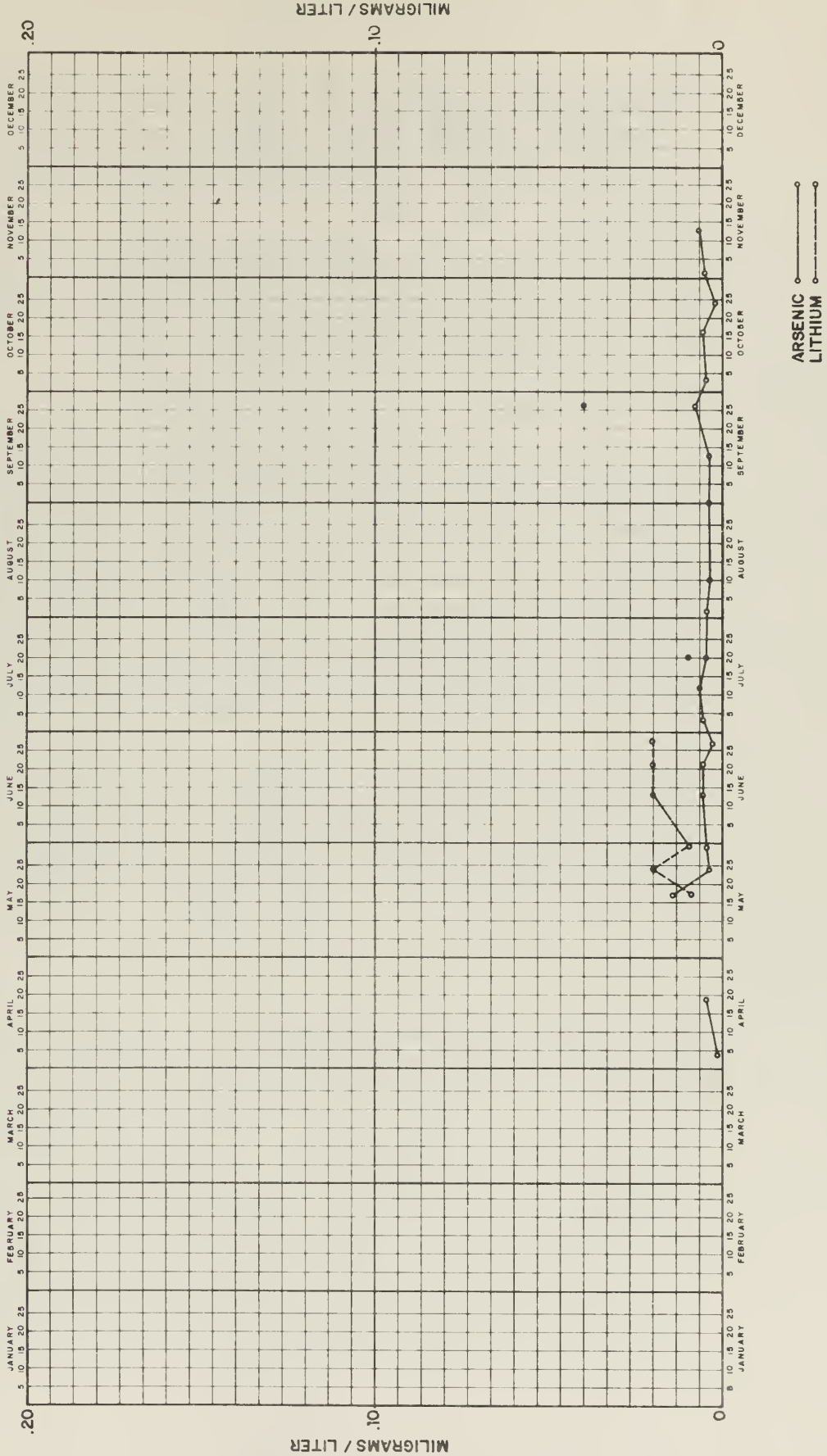


Figure 1-9

ARSENIC AND LITHIUM CONCENTRATIONS RECORDED AT
THE CORRAL GULCH EAST OF TRACT C-a GAGING STATION



These four are S7, S8, S11 and S12. The remaining holes, S6, S13 and S14, were dry when drilled and have not had any water in them up to the end of this reporting period. Table 1-7 is a summary of the field data taken when the seven alluvial holes were drilled. Figure 1-10 is an example of the shallow alluvial hole completions.

The first water quality samples were taken during December 1974, for the alluvial aquifer monitor holes. As of February 28, 1975 the analyses have not yet been completed. This data will be presented in the next Quarterly Report.

1.2.4 Drilling Program

Hydrologic data were acquired during the core drilling program described under the geologic program. This was done to gather as much hydrologic information as possible so that the hydrologic program could be planned to produce the data required. Several categories of hydrologic data were collected during the drilling and coring of the various holes on and around Tract C-a. This included water production, water quality, informal pump test data, and production logging information. The method used, and intervals in which this data was collected, was based upon the Area Oil Shale Supervisor's stipulations and approvals, as well as major knowledge from previous area investigations.

Data were collected during drilling of 13 core holes, four monitor holes north and east of the tract, and four large diameter drill holes for pump testing. The drilling and coring program commenced with the drilling of Core Hole No. 6 and was finished with the completion of large diameter pump hole D-19. Figure 1-11 is a map showing all the holes on the tract as well as off-tract monitor holes.

1.2.4.1 Water Production

Water production was continuously monitored during drilling. This was done because water entering the borehole from a subsurface aquifer during the course of air drilling will be forced to the surface of the hole along with the cuttings. At the surface, air, water and cuttings travel through the "blooey line" to a stilling basin (steel tank) and pit. A 6" x 15" Parshall flume with a Stevens Type F recorder was installed on the outlet of the "blooey pit" to measure water production with respect to time. The production record was then referenced to the drilling depth record (geolograph) to assist in determining at what depth significant aquifers were encountered. Figure 1-12 is an example of the water production versus depth plots which have been submitted to the Area Oil Shale Supervisor.

TABLE 1-7

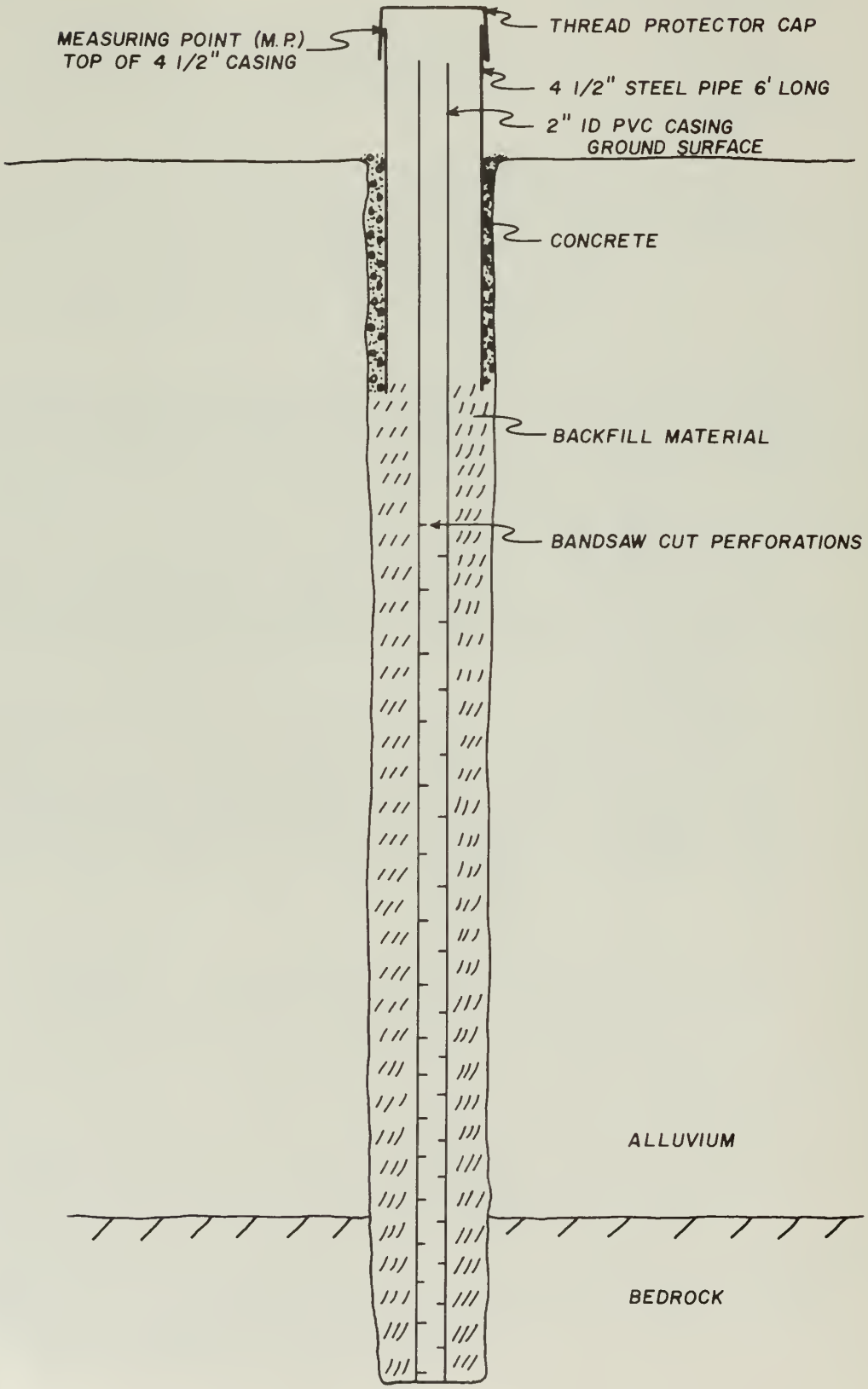
AQUIFER TEST HOLE INFORMATION

Test Well	Drilled Depth (ft.)	Depth of Base of Alluvium (ft.)	Casing Record 2" ID PVC Non-perforated (ft.)	Casing Record 2" ID PVC Perforated (ft.)	Water Level Below MP (ft.)	MP From Ground Surface (ft.)	Depth Water From Ground Surface (ft.)	Measured Depth of Hole Ground Surface (ft.)	Date Measured	Time Measured
S-6	12	8	5.5	8.5	Dry	2.75	Dry	10.7	12/8/74	3:00 PM
S-7	44	39	14.5	31.5	24.52	2.25	22.27	38.9	12/8/74	3:30 PM
S-8	50	45	12	40	40.16	2.20	37.96	45.9	12/8/74	4:10 PM
S-11	66	59	8	60	47.18	2.70	44.48	58.7	12/9/74	12:30 PM
S-12	87	81	29	60	34.79	2.60	32.19	43.3	12/9/74	8:00 AM
S-13	28	22	10	20	Dry	2.20	Dry	25.8	12/9/74	9:30 AM
S-14	50	44	12	40	Dry	2.35	Dry	48.8	12/9/74	10:00 AM

FIGURE 1-10

GENERAL CONSTRUCTION OF AQUIFER TEST WELLS

NOT TO SCALE



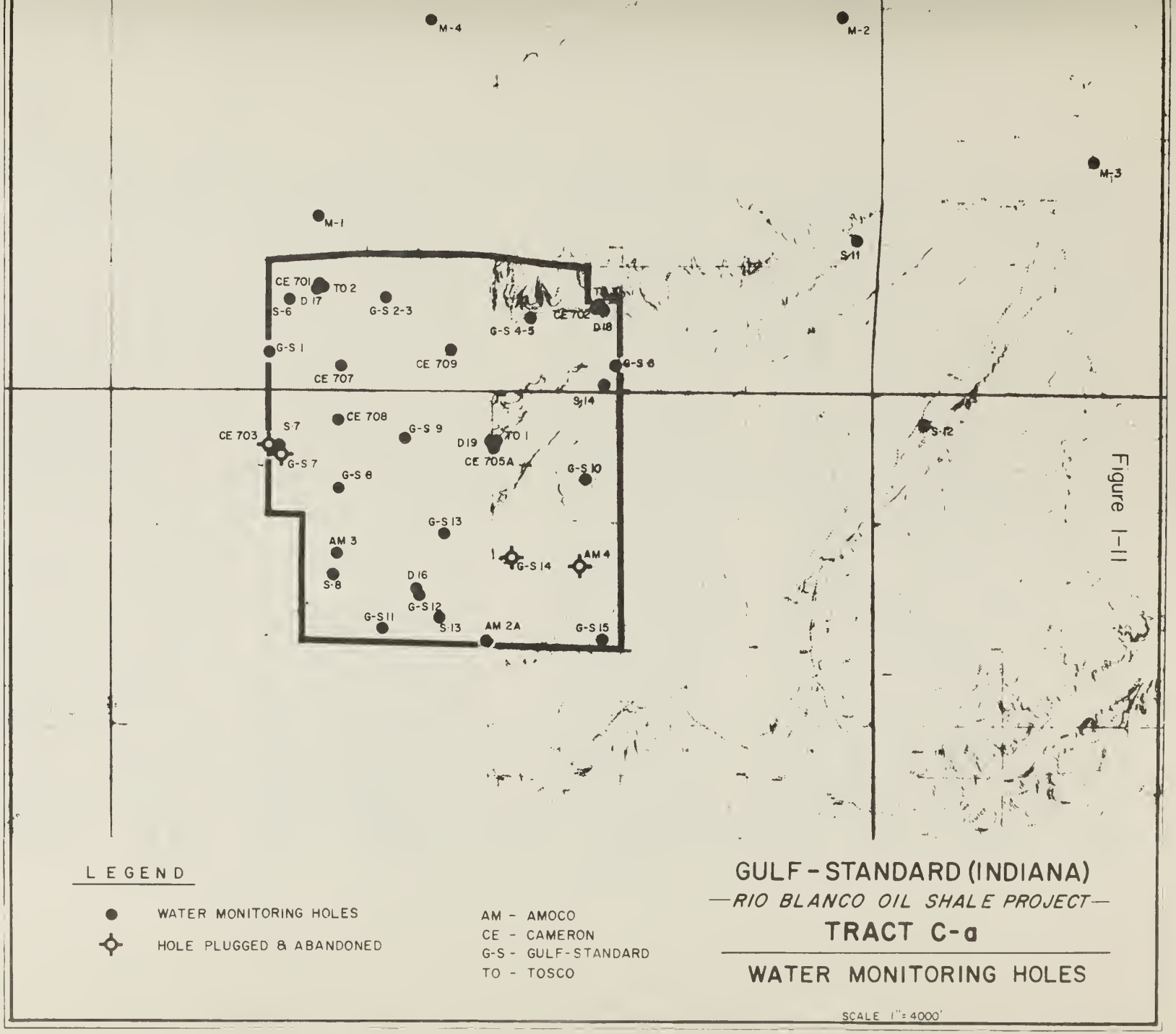
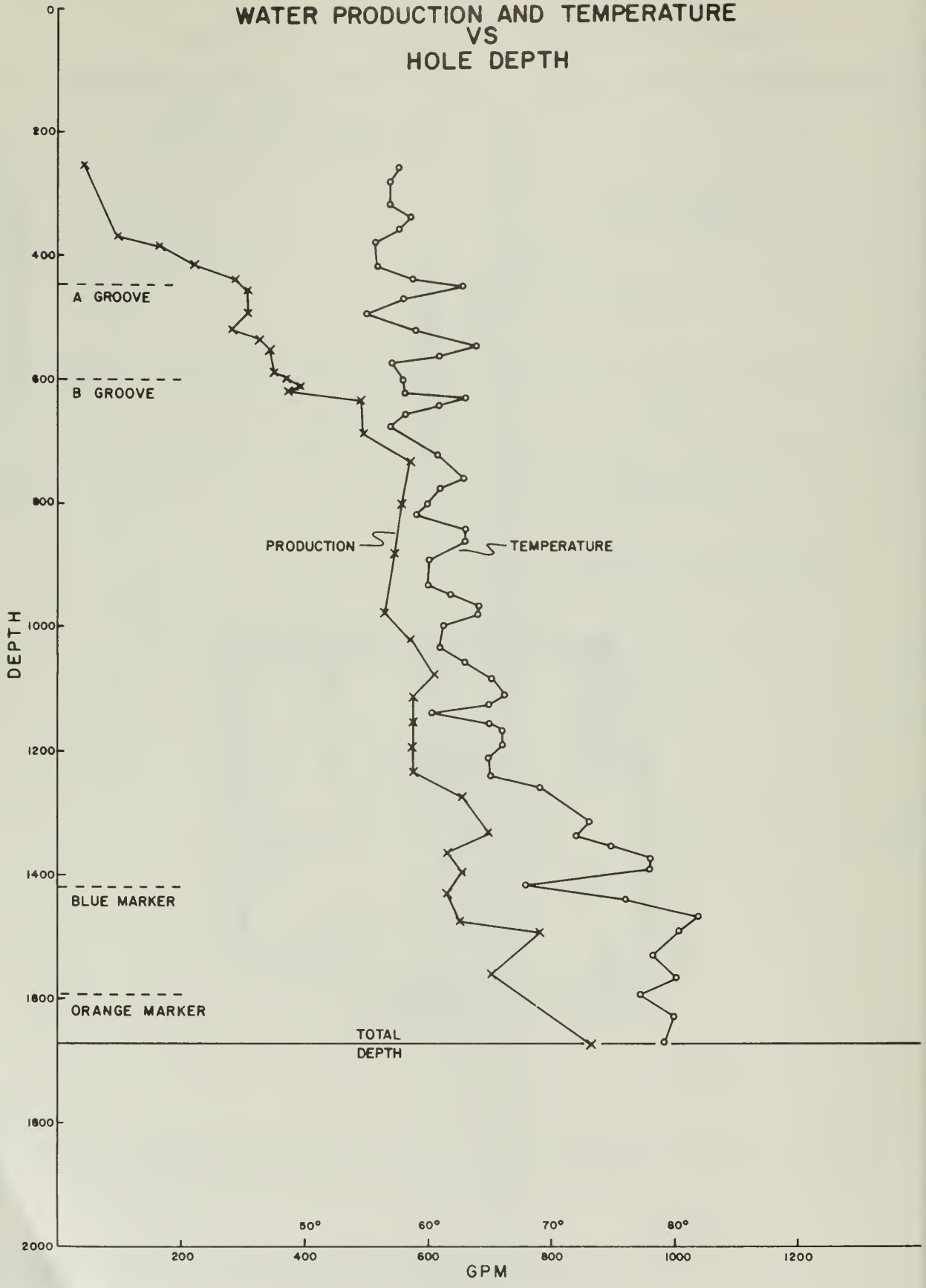

M-4
M-2
M-3
M-1
S-11
CE 701
TO 2
D 17
S-6
G-S 2-3
G-S 4-5
CE 702
D18
G-S 1
CE 709
CE 707
G-S 6
S-14
CE 708
S-7
CE 703
G-S 9
D19
TO 1
CE 705A
G-S 7
G-S 8
G-S 10
S-12
G-S 13
AM 3
G-S 14
AM 4
S-8
D 16
G-S 12
G-S 11
S-13
AM 2A
G-S 15
LEGEND
WATER MONITORING HOLES
HOLE PLUGGED & ABANDONED
AM - AMOCO
CE - CAMERON
G-S - GULF-STANDARD
TO - TOSCO
GULF - STANDARD (INDIANA)
—RIO BLANCO OIL SHALE PROJECT—
TRACT C-a
WATER MONITORING HOLES
SCALE 1" = 4000'

Figure 1-11

Figure 1-12
WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH



In general the drilling program indicated the existence of two aquifer systems in the Tract C-a area. Competent oil shale has very little or no permeability and in itself would be a poor medium for an aquifer. However, fracturing, coupled with the leaching of once-existing saline minerals, has created permeability within the oil shales under Tract C-a. The aquifer systems have been delineated and separated on the basis of differences in water quality and water temperature, discussed in the following paragraphs. The upper aquifer describes a water bearing zone of similar water quality and temperature characteristics which has an upper limit above the Mahogany Zone and a lower limit as far down as the R-5 Zone. The lower aquifer describes a water bearing zone with similar water quality and temperature characteristics in the vicinity of the R-3 Zone and the Blue Marker. With the exception of G-S 4-5, the water flow in the bore hole was from the upper aquifer to the lower aquifer.

Production from the upper aquifer varied from as little as 40 gallons per minute (gpm) to over 1000 gpm, with an average maximum of 247 gpm. Water produced from below the top of the lower aquifer, which included production from both aquifers, varied from 150 gpm to over 1000 gpm. The average maximum of combined production was 438 gpm. Table 1-8 is a summary of the hydrologic data obtained from the Rio Blanco drilling program.

1.2.4.2 Water Quality

Water quality data samples were collected during the drilling and coring of the holes, at the end of the blooey line. At 30-foot depth intervals conductivity, pH and temperature were measured. An example plot of this data is shown in Figures 1-12 and 1-13. Conductivity was obtained using an automatic temperature compensating unit, and a standard conductivity meter. Temperature was measured with standardized mercury thermometers, pH sensitive paper was used to measure pH. The conductivity, pH and temperature data has been submitted to the Area Oil Shale Supervisor.

The conductivity for the upper aquifer ranged from less than 1000 micromhos/centimeter to 1700 micromhos/cm with an average of 1290 micromhos/cm. For the combined aquifers, the range varied from 1300 to a maximum of 20,000 micromhos/cm, the average was 3940 micromhos/cm. The lower aquifer water is generally more alkaline than the upper aquifer water. The dissolved solids averaged 116 milligrams/liter for the upper aquifer and 3235 milligrams/liter for combined aquifer water. The average water temperature from the upper aquifer varied from 54°F to 60°F, averaging 58°F, while the combined aquifer temperature ranged from 59°F to 79°F.

TABLE 1-8
AQUIFER CHARACTERISTICS FROM DRILLING PROGRAM

HOLE NUMBER		GS-1	GS-2-3	GS-4-5	GS-6	GS-7	GS-8	GS-9	GS-10	GS-11	GS-12	GS-13
AQUIFER INTERVAL feet	Upper	260-450	180-470	220-650	180-630	200-400±	400-720	410-610	640-820	670-910	580-620	510-840
	Lower	900-1230	920-1200	1050-1400	1300-1780	1000-1200	1060-1460	1070-1240	1380-1600	1350-1480	1280-1430	1280-1380
STATIC WATER LEVEL feet	Upper (as of 1-15-75)	245	117	75	10	(10)	(340)	323	340	478	407	387
	Composite	270	180	65	50	250	520	370	350	580	560	510
	Lower (as of 1-15-75)	580	208	65	51	--	623	487	360	691	619	543
PRODUCTION RATE gpm (Maximum)	Upper	100	200	560	375	80	70	140	280	125	100	120
	Combined	160	500	865	575	250	250	300	455	310	300	375
APPARENT SPECIFIC CAPACITY gpm/ft.	Upper	.43	1.7	3.6	.50	.46	--	.5	1.6	3.7	.34	2.8
	Combined	.18	.85	6.4	.24	1.1	.84	.63	.24	1.2	1.5	2.3
APPARENT TRANSMISSIVITY t_1, gpd/ft.	Upper	--	3000	6800	19,800	770	--	--	2960	5900	7900	5200
	Combined	170	1800	11,800	375	1670	1200	1200	570	1640	7300	3300
AVERAGE SPECIFIC CONDUCTANCE umhos/cm	Upper	1000	1160	1800	1200	1000	1100	1520	1160	980	1700	1100
	Combined	2055	2760	2850	2840	1500	2250	2800	4500	3700	3100	2800
AVERAGE TEMPERATURE °F	Upper	57	59	60	59	57	59	58	61	58	59	55
	Combined	59	71	76	75	62	64	69	79	71	70	70
AVERAGE pH	Upper	6.7	7.0	6.7	7.6	7.0	7.0	6.7	7.1	7.0	7.0	7.0
	Combined	6.8	7.4	7.5	7.9	7.0	7.5	7.4	8.1	8.1	7.7	7.6
AVERAGE DISSOLVED SOLIDS milligram/liter	Upper	1350	1000	1000	840	800	720	1300	1250	1700	2000	1370
	Combined	3440	2300	1900	3600	1280	1400	2100	1900	2940	3000	2300

*Representative value

**E logs

TABLE 1-8 (Continued)

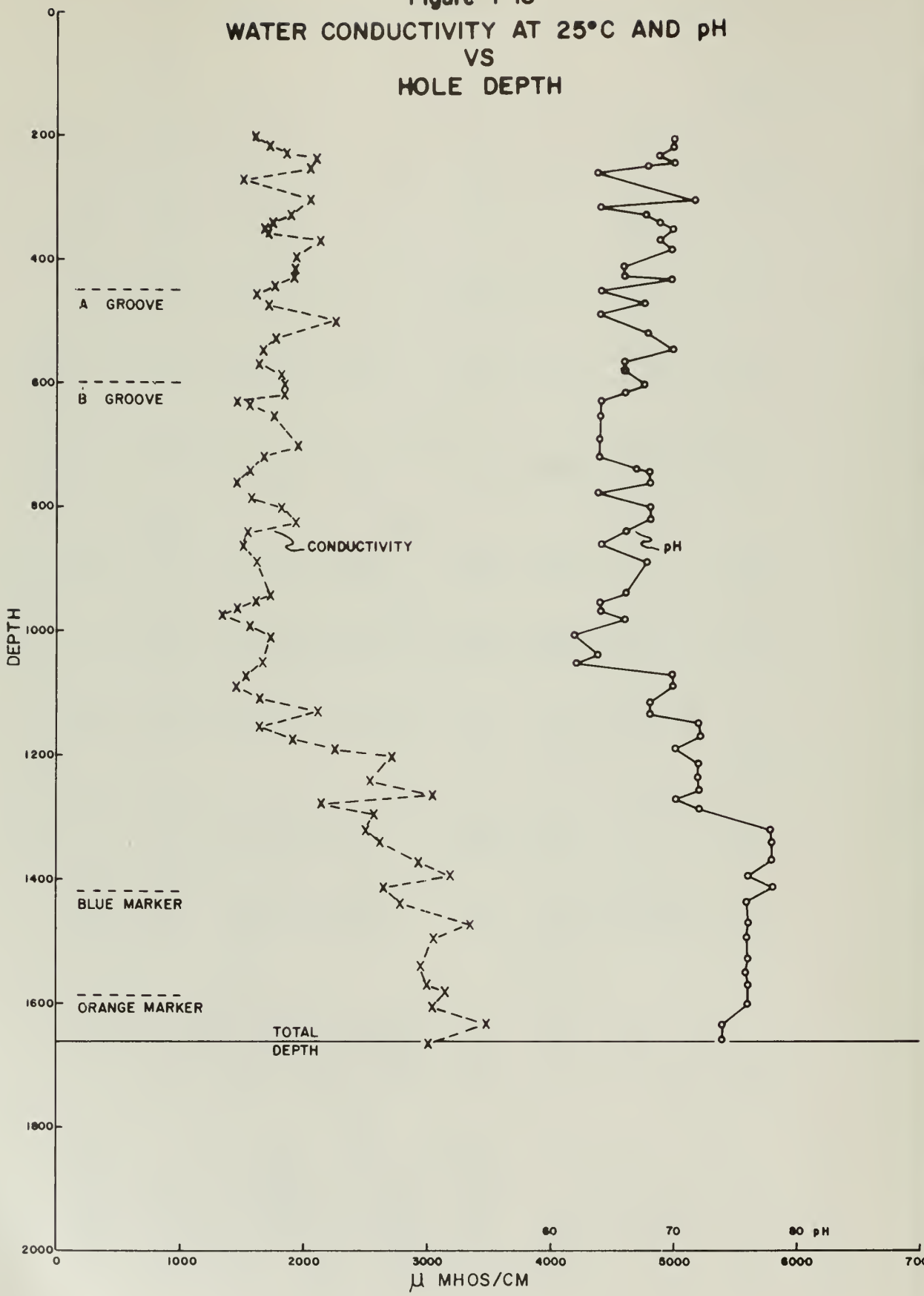
HOLE NUMBER		GS-14	GS-15	GS-M1	GS-M2	GS-M3	GS-M4	GS-016	GS-017	GS-018	GS-019
AQUIFER INTERVAL feet	Upper	680-780	600-700	600-800	360-1160	100-1000	840-960	580-620	220-310	350-440	220-440
	Lower	1200-1400±	1300-1400	1360-1500	1980-2030	1450-1650	1720-1990	128-1430	940-1020	1375-1540	960-1100
STATIC WATER LEVEL feet	Upper (as of 1-15-75)	(330)	279	643(50)**	241	22	487	--	--	--	--
	Composite	410	320	700	320	90	540	--	--	--	--
	Lower (as of 1-15-75)		334	798	348	128	535	--	--	--	--
PRODUCTION RATE gpm (Maximum)	Upper	40	100	20	440	1020	200	190	120	1060	360
	Combined	300	500	150	510	1000	260	230	85	415	660
APPARENT SPECIFIC CAPACITY gpm/ft.	Upper	.43	2.8	.3	2.2	8.2	.9	--	--	--	--
	Combined	3.3	.66	.4	--	3.3	--	--	--	--	--
APPARENT TRANSMISSIVITY t_1, gpd/ft.	Upper	1900	6400	510	3100	12,000	1200	--	--	--	--
	Combined	5300	1320	410	--	8800	--	--	--	--	--
AVERAGE SPECIFIC CONDUCTANCE umhos/cm	Upper	1100	1100	1200	1000	1040	1500	1200	1200	2200	950
	Combined	2950	3400	3400	8200	16,500	3840	4200	1500	4800	1750
AVERAGE TEMPERATURE °F	Upper	58	59	54	61	54	61	56	56	58	53
	Combined	72	76	67	71	61	72	67	56	77	61
AVERAGE pH	Upper	6.8	7.1	6.9	7.1	6.9	7.1	7.0	6.9	7.2	7.0
	Combined	8.4	8.3	8.5	7.8	8.5	7.9	8.6	7.1	8.6	7.3
AVERAGE DISSOLVED SOLIDS milligram/liter	Upper	1050	1150	800	800	900	950	1400	950	1600	830
	Combined	2250	2500	2600	--	18,000	1950	2900	1300	3780	1800

*Representative value

**E logs

Figure 1-13

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH



Samples were collected for standard wet chemical and spectrographic analyses, generally, four times during the drilling or coring of each hole. The first sample was taken at a depth where the first significant water production from the drill hole occurred or near the top of the upper aquifer. The second sample was taken in the vicinity of the B groove. This sample should represent the water in the upper aquifer. The third sample was taken at the first significant change in water production and water quality below the bottom of the upper aquifer. Generally, this sample was collected in the vicinity of the R-3 zone, and could be considered the top of the lower aquifer. This sample would represent a mixture of waters from the upper aquifer and the upper portion of the lower aquifer. The fourth sample was collected after the hole had reached total depth and would be a mixture of waters from both the upper and lower aquifers. The results of these analyses for each of the core holes has been submitted to the Area Oil Shale Supervisor.

In addition to the above four samples collected from each hole, a water sample was collected at 200-feet intervals during the drilling, as required by the Area Oil Shale Supervisor. These samples are presently being stored at the office of Wright Water Engineers, Inc.

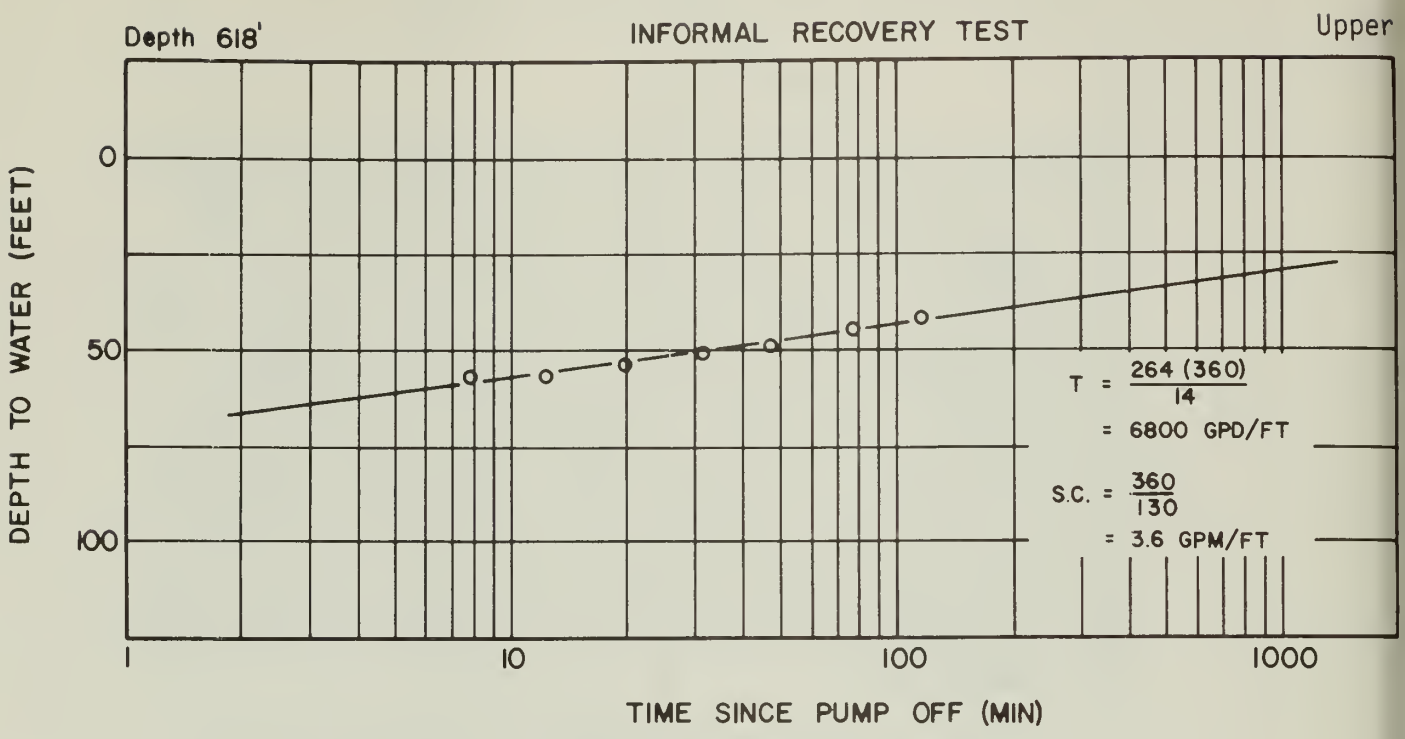
1.2.4.3 Informal Pump Tests

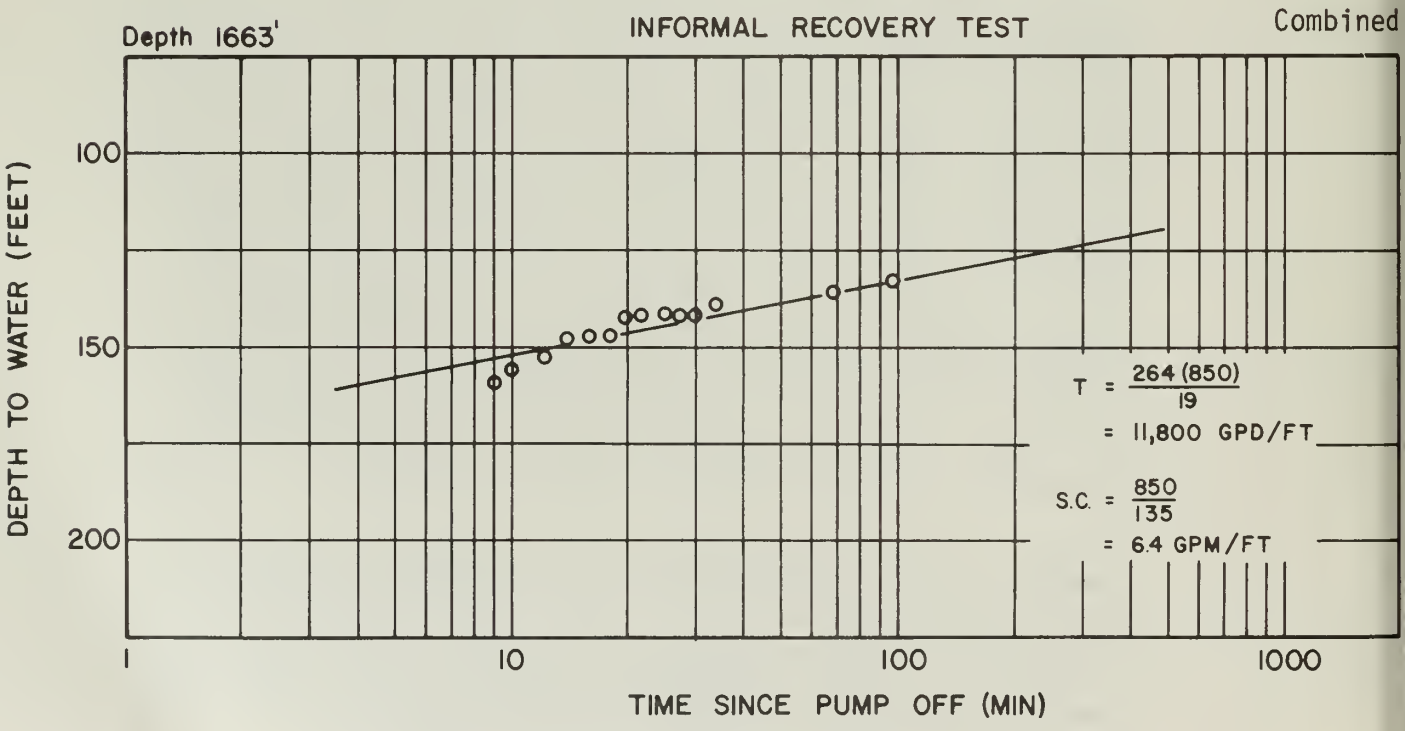
Informal pump tests were conducted during drilling in order to generally define aquifer properties, such as the transmissivity and the specific capacity. An informal pump test consists of forcing the inflowing water out of the bore hole by injecting air under pressure through the open drill pipe to a point below the aquifer to be tested. This procedure differs from drilling in that the drill bit is off bottom. The "pumping" is continued for two hours (with consequential water level drawdown), during which time water production was monitored. The air compressors were then shut off to allow the water level in the bore hole to recover to the original level. A pressure bomb was lowered into the drill pipe to continuously monitor the rising water level. Generally, the holes were allowed to recover for about two hours. From the production rate and the rate of recovery the Jacobs method can be used to approximate transmissivity and specific capacity.

Figure 1-14 is the simplified Jacobs plots for the upper and combined aquifers, which and is only an approximation of the true aquifer characteristics. The transmissivity (T values) shown in Table 1-14 and in the simplified Jacobs plots should therefore be considered apparent transmissivities. Also, the specific capacities calculated on the simplified Jacobs plots should be considered apparent specific capacities.

Figure 1-14

SIMPLIFIED JACOBS PLOTS FOR THE UPPER AND COMBINED AQUIFERS





The transmissivity indicates the ability of water to move through the aquifer; an aquifer with a high transmissivity can transmit greater amounts of water than an aquifer with a lower transmissivity. The apparent transmissivities for the upper aquifer ranged from less than 1000 gallons per day (gpd) per foot to 20,000 gpd/ft., and averaged 5,140 gpd/ft. The apparent transmissivities for the combined aquifers ranged from less than 200 gpd/ft. to approximately 12,000 gpd/ft. and averaged 3,089 gpd/ft.

The specific capacity is an expression of the production capability in respect to the amount of drawdown experienced at a known production rate. A small specific capacity represents limited aquifer recharge into the well. Apparent specific capacities averaged 1.3 gallons per minute per foot (gpm/ft) for the upper aquifer and 1.5 gpm/ft. for the combined aquifer tests.

1.2.4.4 Geophysical Logs

Geophysical logs were run after the total depth of each hole was reached. The spinner survey and temperature surveys are of prime interest. Figure 1-15 is an example plot showing temperature and spinner data with respect to depth. This data for each of the Rio Blanco holes has been submitted to the Area Oil Shale Supervisor.

The temperature survey indicates the water temperature in the bore hole versus depth. This data can be used in some cases to interpret the flow, being either downhole or uphole, or zone where water is either intering or leaving the bore hole, or no flow at all.

The spinner survey, though interpretive, is more definitive of direction and velocity of flow with hole depth. Measurements are made from these runs. The gallons per minute (gpm) of flow versus depth can be calculated from these measurements by knowing the spinner tool specifications and the bore hole size. The gpm/ft. entering or leaving the bore hole can also be calculated. Figure 1-16 shows a plot of spinner survey data such as have been submitted to the Area Oil Shale Supervisor.

1.2.5 Completion Program

A dual monitor hole completion was designed to obtain water levels and water samples from one hole for the two different aquifers. This method of completion also allows the tubing to be removed so individual zones could be tested or pumped. This method of completion for monitor holes has been approved

Figure 1-15

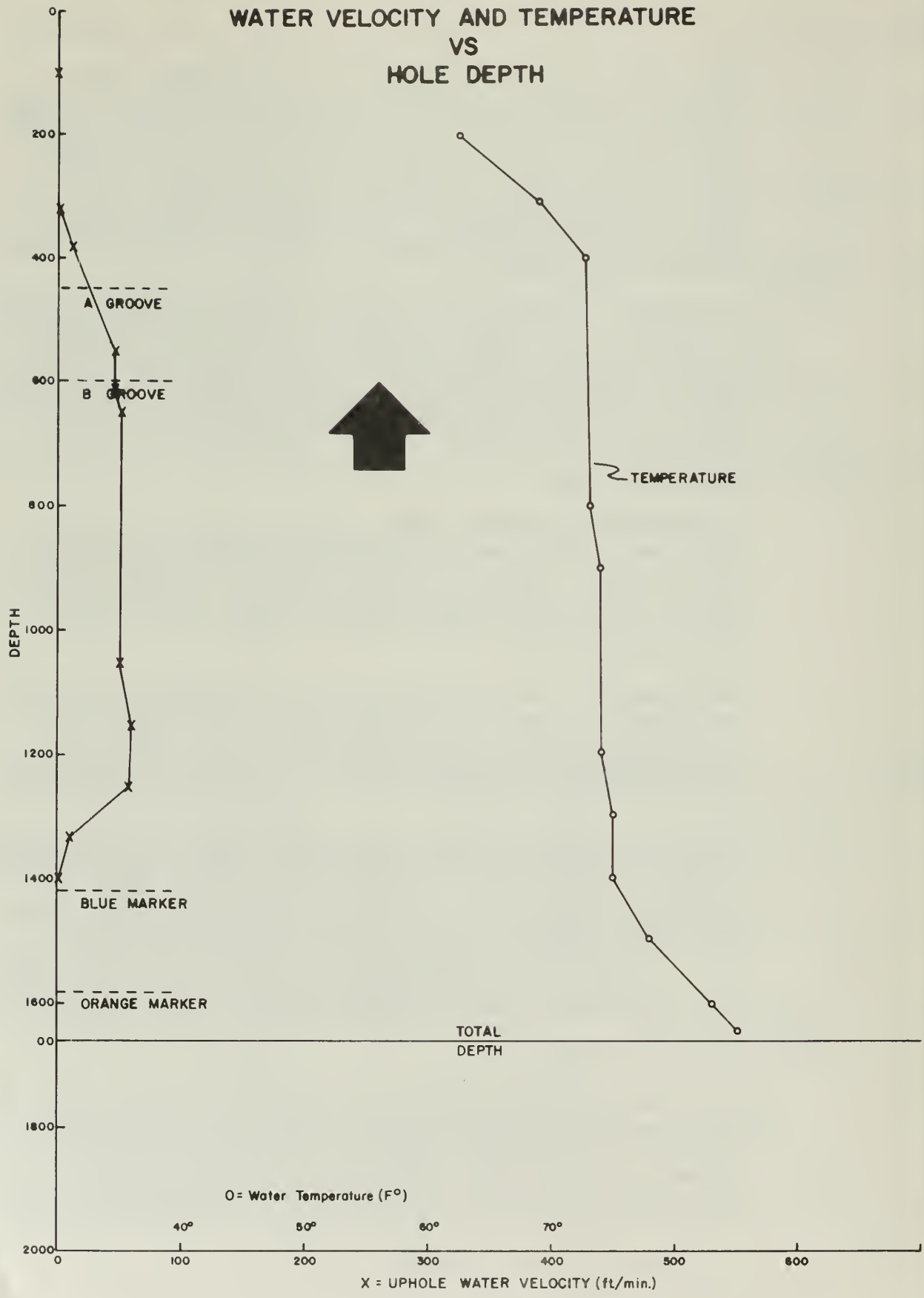
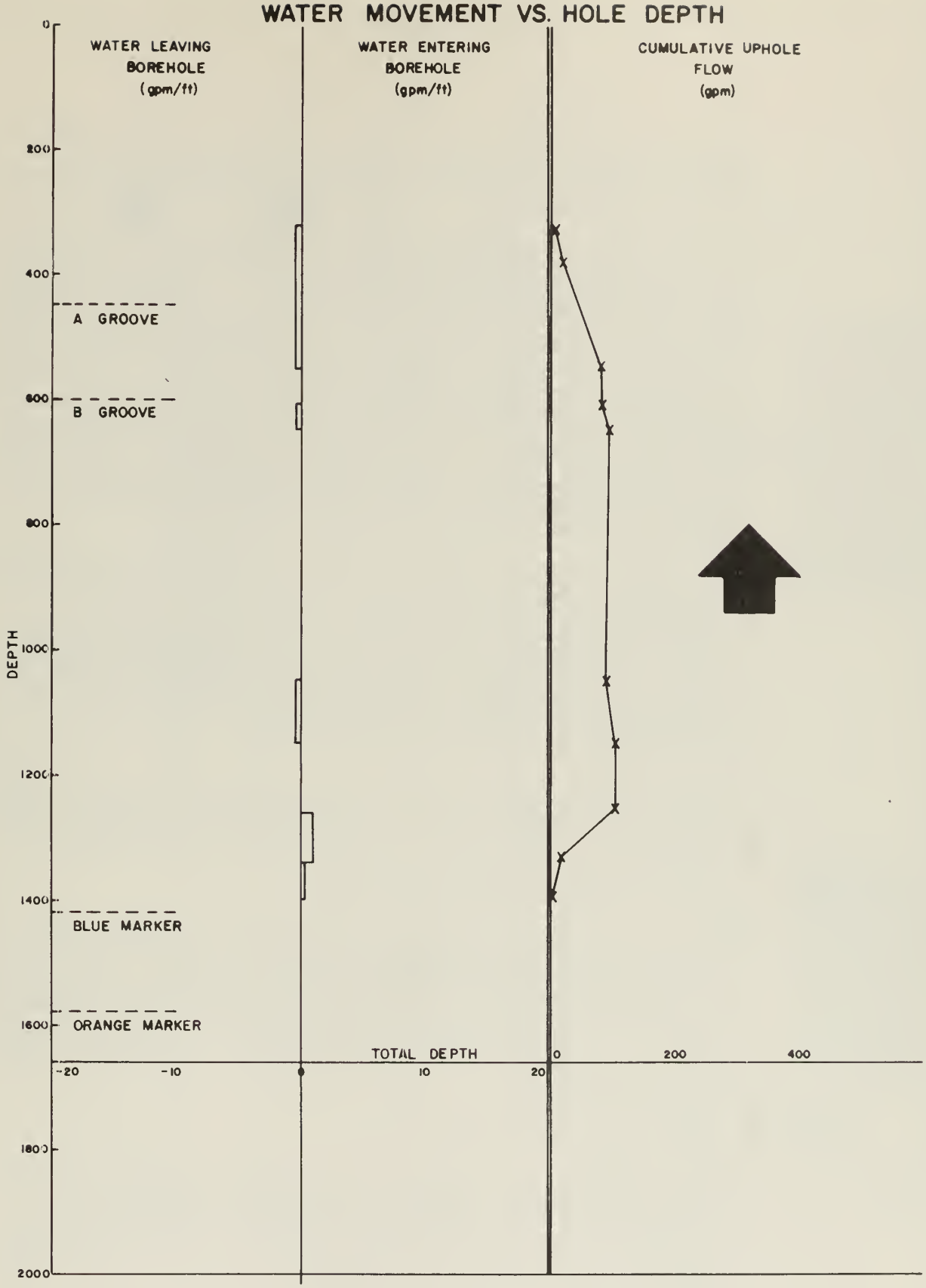

WATER VELOCITY AND TEMPERATURE
VS
HOLE DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
00
1800
2000
A GROOVE
B GROOVE
BLUE MARKER
ORANGE MARKER
TOTAL
DEPTH
TEMPERATURE
O= Water Temperature (F°)
40°
50°
60°
70°
0
100
200
300
400
500
600
X = UPHOLE WATER VELOCITY (ft/min.)

Figure 1-16
WATER MOVEMENT VS. HOLE DEPTH



by the Area Oil Shale Supervisor. Figure 1-17 is an example of the completion diagrams that have been submitted to the Area Oil Shale Supervisor. The completion method is as follows.

In most cases, a 5-1/2 inch liner, or 4-1/2 inch liner (depending on original hole size) was run in the hole to a depth of approximately 250 feet below the bottom of the upper aquifer, as indicated by preliminary drilling data. Approximately 200 feet at the bottom of this liner was cemented in place. After the cement had cured, a cement bond log was run to determine the top of the cement so that the liner could be cut off above the cement. The upper portion of the liner was then removed from the hole. A 2-3/8 inch string of tubing was used to set a tension type packer in the liner approximately 30 feet below the top of the liner. This string of tubing with the packer and the liner act as a seal to isolate the two aquifers and allows the lower aquifer system to be monitored.

A second string of tubing was run to insure that data could be collected for the upper aquifer. In most cases, the second string of tubing is 2-3/8 inches in diameter. However, in some of the older holes, small surface casing was run which only allows the second string to have a diameter of 1-1/2 inches. In both cases, perforated tubing was run where the preliminary data from drilling indicated the upper aquifer to be present.

Some of the holes were not desirable as monitor holes and were cemented from top to bottom as required by the Area Oil Shale Supervisor. Table 1-9 is a summary of the hole completions.

1.2.6 Upper and Lower Aquifer Pump Tests

The pump testing program was begun early in January, 1975. A total of four upper aquifer holes and four lower aquifer holes is scheduled for pump testing. Because of the nature of this program, the data will not be available until approximately 30 days after the end of the last pump test. It is anticipated that this information will be finalized in time for our next Quarterly Report.

1.2.7 Deep Aquifer Monitoring

This monitoring program consists of gathering data on water levels, and water temperature, and collecting samples for testing of various chemical constituents. This program was initiated in December of 1974, and will be discussed in more detail in subsequent Quarterly Reports.

Figure 1-17

DUAL MONITOR HOLE COMPLETION DIAGRAM

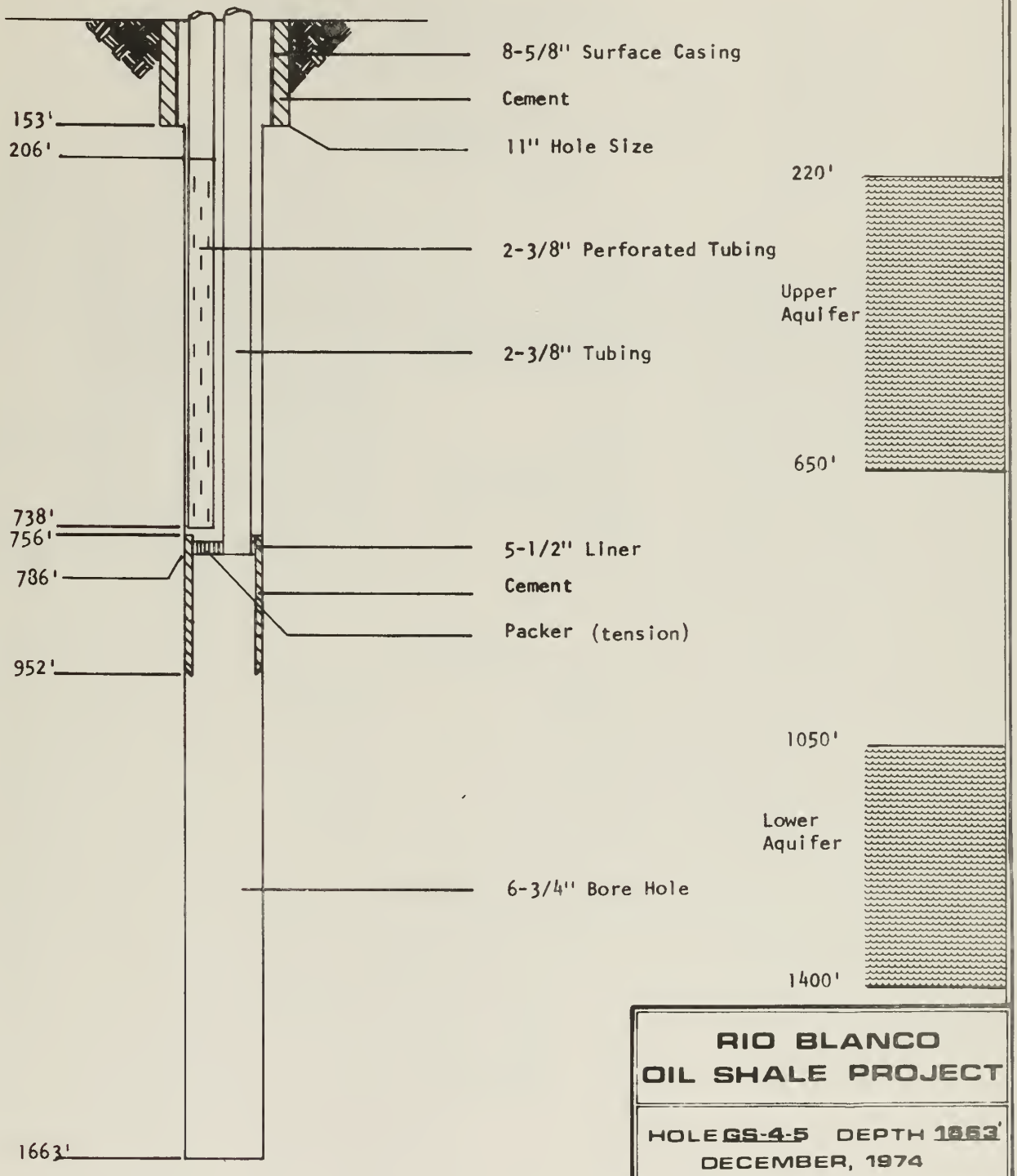


TABLE 1-9

DRILL HOLE COMPLETION SUMMARY
OF MONITORING HOLES

ON-TRACT

Holes		Aquifers	Holes		Aquifers
G-S	CH 1	U & L	CE	CH 701	U Pump Test Only
G-S	CH 2-3	U & L	CE	CH 702	U & L
G-S	CH 4-5	U & L	CE	CH 705-A	U Pump Test Only
G-S	CH 6	U & L	CE	CH 707	U & L
G-S	CH 8	L Lower Monitor Only	CE	CH 708	U & L
			CE	CH 709	U & L
G-S	CH 9	U & L	TOSCO	CH 1	U & L
G-S	CH 10	U & L	TOSCO	CH 2	U & L
G-S	CH 11	U & L	TOSCO	CH 3	U Pump Test Only
G-S	CH 12	U & L Monitor & Upper Pump Test	Amoco	CH 2-A	U & L
			Amoco	CH 3	U & L
G-S	CH 13	U & L			
G-S	CH 15	U & L	22 HOLES TOTAL		

OFF-TRACT

Holes	Aquifers
M - 1	U & L
M - 2	U & L
M - 3	U & L
M - 4	U & L

ON-TRACT PLUGGED AND ABANDONED

Holes		
CE	CH	703 (Drilled)
G-S	CH	7
G-S	CH	14
Amoco	CH	4

U = Upper Aquifer

L = Lower Aquifer

1.2.8 Data Input to Mathematical Model

A computerized mathematical model has been selected. This model will be used to forecast dewatering and production rates for various pumping and mining configurations. It should be noted, however, that the data input to the model will come from two sources, the first being the information gained from the drilling and pump testing on and around the tract, and the second being the published data for the basin from the U.S.G.S.

1.2.9 Dewatering Analysis

In order to do a dewatering analysis of this magnitude, the mathematical model must first be perfected and the input data finalized. Therefore, it is anticipated that it will be several months before information from the dewatering analysis will be available.

2.0 ENVIRONMENTAL BASELINE DATA GATHERING PROJECT

A. Description of Tract C-a Oil Shale Lease, Piceance Creek Basin, Colorado.

Tract C-a is located within that portion of the Piceance Creek Basin in northwestern Colorado which drains into the White River. The tract is approximately 27 miles southwest of Meeker and encompasses approximately 8 square miles (5,090 acres).

The topography of Tract C-a is characterized by northeast trending canyons and ridges. The slopes of the canyon walls are steep, the valley floors are narrow, and the ridges are broad and rounded. Altitude within the tract varies from 6,600 feet in Corral Gulch to 7,400 feet on the ridges near the southwest portion of the tract. The tract is accessable from Highway 64, running between Rangely and Meeker, and Highway 13 between Rifle and Meeker. The last 25 miles into Tract C-a are over gravel road and dirt jeep trails.

The principal drainages on and near the tract are Corral, Water and Box Elder Gulches, and Dry Fork: all of which flow into Yellow Creek. Stake Springs Draw is the major drainage southeast of the tract. North of the tract, Big Duck Creek is the nearest principal drainage. All these drainages exhibit a general northeast flow. The majority of streams are intermittent and flow only during the period of spring runoff and following locally heavy rains. Yellow Creek, which receives all surface runoff from the tract, has a drainage area of 258 square miles. Yellow Creek is intermittent near Tract C-a, but is free-flowing near its confluence with the White River.

The annual precipitation in the vicinity of Tract C-a varies from 12 to 24 inches. Slightly less than half of the precipitation occurs as snow from December to April. Spring precipitation is low. However, occasional thunderstorms with accompanying flash floods occur during the latter part of the summer. Summer temperatures can reach 100 degrees and winter temperatures may drop to 40 degrees below zero. The frost-free season varies from 124 days at the lower elevations to 50 days at the upper elevations in the Piceance Creek Basin.

B. Objectives of the Environmental Baseline Studies

In January of 1974, Gulf Oil Corporation and Standard Oil Company (Indiana) submitted the winning bid for Colorado Oil Shale Lease Tract C-a and formed Rio Blanco Oil Shale Project (RBOSP) to operate the lease. To meet obligations set forth in the lease, an extensive environmental program was developed. Although these lease stipulations identified the type of data to be collected, design of the environmental program was

specifically the province of RBOSP and its contracted experts, with subsequent approval by the Area Oil Shale Supervisor of the United States Geological Survey.

Two objectives were considered in developing the programs: compliance with lease stipulations and formulation of a scientifically sound baseline program, not necessarily in that order. The following goals were specified by RBOSP's scientific experts:

1) Identify any potential data gaps which might exist in lease stipulations, and develop programs to include these.

2) Evaluate lease stipulations which, if amended, might best serve the spirit enunciated in the lease.

3) Assign technical priorities and allocation of money for each component of the baseline data accumulation program to obtain the appropriate balance between scientific and economic considerations.

After thorough evaluation and study, a final scope of work was submitted to and approved by the Area Oil Shale Supervisor after review and recommendation by the Oil Shale Environmental Advisory Panel. Programs were designed to determine meteorology and air quality, to describe plant and animal relationships, to characterize soils, and to identify scenic areas and archaeological artifacts.

The decision was made by RBOSP to expand the study area within some programs to encompass a 5-mile radius of the tract. Emphasis was placed on Tract C-a, potential disposal sites and scenic areas. Flexibility to respond to those changes indicated by the constantly expanding data base, while retaining compatibility with original objectives, was written into the programs. Baseline data obtained from these programs will be used to characterize the physical and biological components of the tract, and to develop a monitoring program to measure perturbations in the system due to development.

C. Components of environmental baseline data accumulation program.

The environmental baseline program is a five-part integrated study of air quality, meteorology, terrestrial ecology, aquatic ecology, and other special environmental studies (soils study, archaeology, etc.). A work breakdown structure chart of the Environmental Baseline Data Gathering Project is shown in Figure 2-1.

Air quality and meteorological studies are being conducted for RBOSP by EG&G, Inc. The terrestrial ecology program is under contract to Ecology Consultants, Inc. Aquatic baseline studies are being made by NUS Corp. The soils survey will be contracted in the spring of 1975. Archaeological clearances have been performed by Dr. Alan P. Olson, University of Denver.

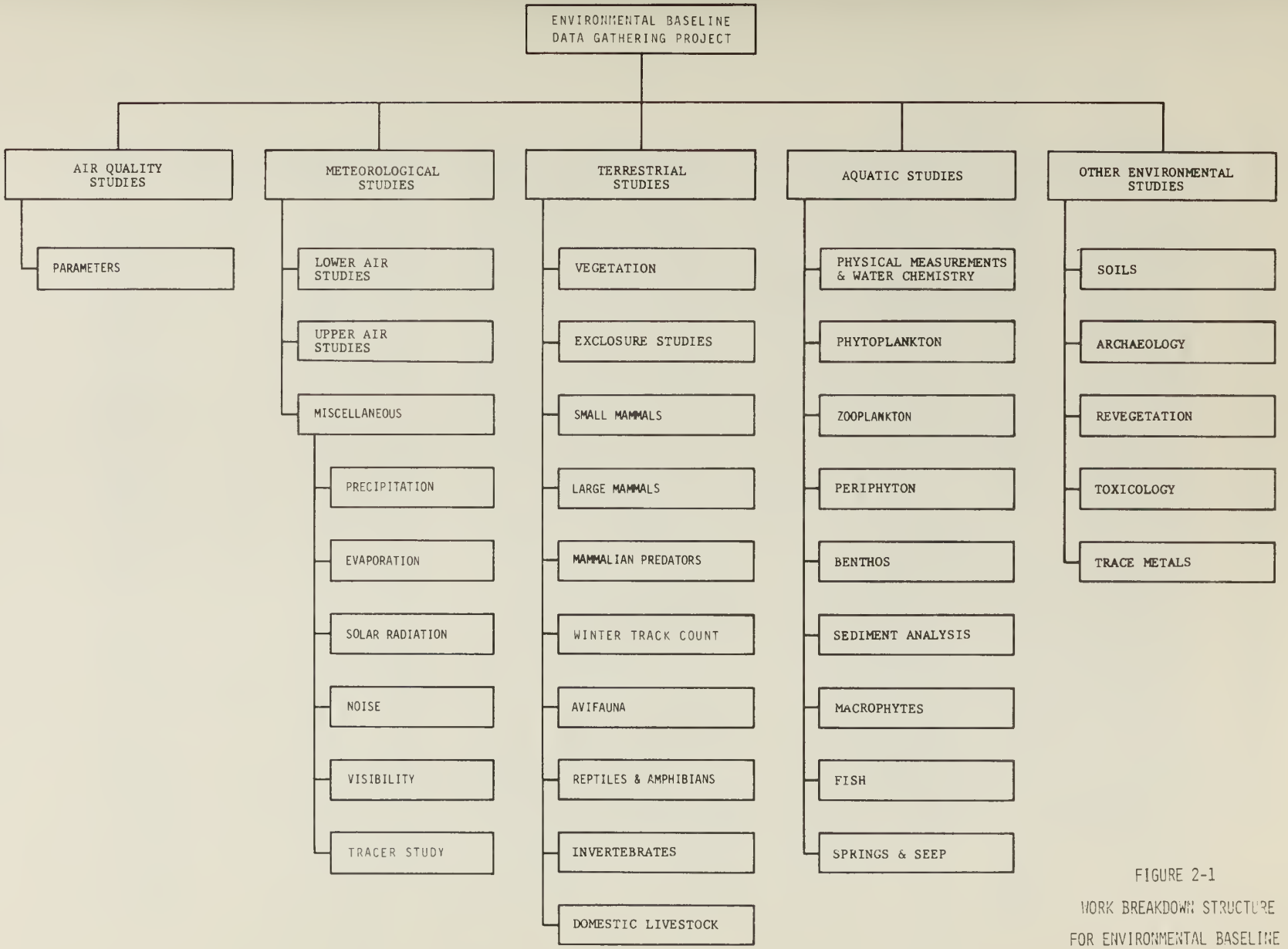


FIGURE 2-1
WORK BREAKDOWN STRUCTURE
FOR ENVIRONMENTAL BASELINE
DATA GATHERING PROJECT

Major archaeological surveys will be undertaken during the summer of 1975 by Dr. Olson.

Limnetics, Inc. administers all programs mentioned above, being responsible for the timely completion and quality assurance of all phases of the environmental data accumulation in order to satisfy the environmental requirements specified in the lease as well as to insure the scientific integrity of the program as a whole.

This section summarizes progress of the environmental programs during the first quarter of study from October 1974 through February 1975. No attempt is made to interpret environmental phenomena or define broad ecological trends since insufficient data have been collected over too brief a time span. Rather, objectives and methods are described and data summaries are presented as befits such an early stage in this program.

2.1 Air Quality

Air quality studies are designed to at least meet and in some cases exceed, the following lease stipulations: "in the collection of baseline data, the Lessee shall monitor air quality over at least 90 percent of each lease year, during which monitoring is required, using four strategically-located stations. One of the stations shall be at the expected point of maximum concentrations, or as close to that point of maximum concentration as feasible."

"The lessee shall monitor air quality for sulphur dioxide, hydrogen sulphide, and suspended particulates, using automatic instruments with continuous recorders, when applicable. The Lessee shall also monitor, under the same conditions, hydrocarbons, oxides of nitrogen, and other pollutants, where the Area Oil Shale Supervisor has determined that such monitoring is necessary to determine baseline air quality or to conduct an effective monitoring program."

The air quality data acquisition system for the Rio Blanco Oil Shale Project consists of four monitoring sites: a central site and three remote sites. The central site contains a data processing computer which receives data directly from the central site and from the remote site through radio links. Each site has analog recorders to record data in case of a computer or radio link failure. The digital data are recorded on magnetic tape and hard copy printout as well as on the strip chart back-up system. The particular air quality parameters which are monitored at each site are delineated on the site diagram Figure 2-2.

Air quality data were recorded at the required recovery rates during February 1975. Most parameters were measured at the low levels expected in the Piceance Creek Basin. Only a few measurements above minimum detectable levels were recorded and their source (instrumental error, local source or ambient air) is being investigated.

2.1.1 Parameters

2.1.1.1 Objectives

Air quality is measured to determine background concentrations prior to any major development on the tract, in order to at a minimum meet lease stipulations, and in some cases exceed these.

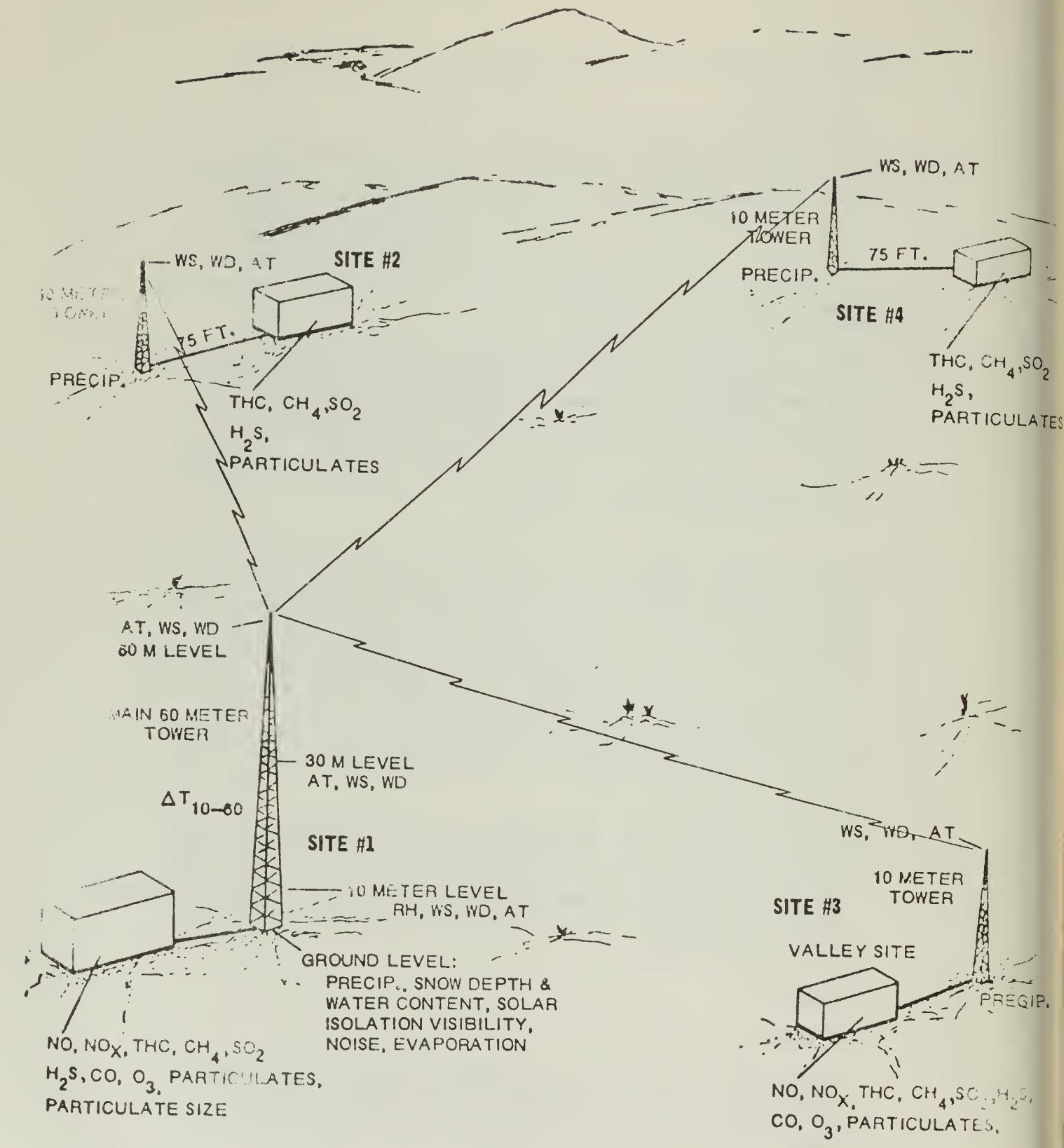


Figure 2-2. Meteorological and Air Quality Data Acquisition System for RBOSP, Tract C-a, Piceance Creek Basin, Colorado.

2.1.1.2 Methods

The air is continuously sampled through an intake located ten feet above ground level. This intake is connected to a manifold which supplies air samples to gas monitoring equipment. The data from the monitoring equipment are then fed into the onsite computer which performs preliminary analysis. Air quality parameters are indicated in Table 2-1.

2.1.1.3 Results

The minimum, maximum and average values of each of the air quality parameters for February 1975, are tabulated in Table 2-2.

2.2 Meteorology

According to the environmental lease stipulation, the Lessee "shall establish a meteorological station in reasonable proximity to each proposed plant site to monitor, at least 95 percent of the time over each lease year during which monitoring is required, wind direction and speed (vane and anemometer) at three levels, one at least 100 feet above the surface of the plant site, one at approximately 30 feet above the surface of the plant site, and one at an intermediate level, and temperature at two levels, one at least 100 feet above the surface of the plant site, and one at approximately 30 feet above the surface of the plant site, and humidity at one level. The Lessee shall maintain records of all baseline data collection and monitoring programs." As a minimum the RBOSP is satisfying these stipulations.

The meteorological program has two major study regimes (lower air and upper air studies). Meteorological parameters to 60 m above ground level are determined in the lower air studies. In the upper air studies wind and temperature measurements to approximately 4,000 m are made.

The meteorological data acquisition system consists of four monitoring sites, a central site and three remote sites (Figure 2-2). The data links and recording systems are similar to those discussed under the air quality section. Specific meteorological parameters studied are indicated on Figure 2-2.

During the checkout of the RBOSP meteorological and air quality data acquisition system, meteorological parameters were recorded in analog form from Decemberl, 1974 through January 31, 1975. The majority of these data is probably recoverable. This recovery of the data will be persued.

2.2.1 Lower Air Studies

TABLE 2-1

AIR QUALITY PARAMETERS MEASURED AT EACH SITE
RBOSP, TRACT C-a

Measured Parameters	Sites 1	2	3	4
Particulates	X	X	X	X
SO_2 (Sulfur Dioxide)	X	X	X	X
H_2S (Hydrogen Sulfide)	X	X	X	X
THC (Total Hydrocarbons)	X	X	X	X
CH_4 (Methane)	X	X	X	X
CO (Carbon Monoxide)	X		X	
O_3 (Ozone)	X		X	
NO (Nitric Oxide)	X		X	
NO_x (Nitrogen Oxides)	X		X	

TABLE 2-2

MONTHLY MINIMUM, MAXIMUM AND AVERAGE
VALUES OF CHEMICAL PARAMETERS MEASURED ON RBOSP
TRACT C-a, FEBRUARY 1975

Parameter	Minimum	Maximum	Average
	Site 1		
O_3	0.021	0.058	0.033
CO	N/A	N/A	N/A
NO	0.001	0.184	0.005
NO_x	0.001	0.189	0.007
CH_4	0.797	1.448	1.335
THC	1.055	1.678	1.426
H_2S	0.000	0.012	0.002
SO_2	0.001	0.005	0.004
	Site 2		
CH_4	1.078	1.557	1.376
THC	1.140	2.049	1.515
H_2S	.001	.012	.004
SO_2	.001	.005	.003

Note: Units expressed in ppm.

TABLE 2-2 (Continued)

Parameter	Minimum	Maximum	Average
Site 3			
CO	N/A	N/A	N/A
NO	N/A	N/A	N/A
NO_x	N/A	N/A	N/A
CH_4	1.036	1.524	1.387
THC	1.230	1.891	1.517
H_2S	0.001	0.007	0.003
SO_2	0.001	0.008	0.001
Site 4			
CH_4	0.988	1.401	1.311
THC	1.016	1.521	1.369
H_2S	N/A	N/A	N/A
SO_2	N/A	N/A	N/A

Note: N/A indicates that the data recovery procedure has not been completed.

2.2.1.1 Objectives

The objectives in measuring meteorological parameters in the lower atmosphere are (a) to supply data necessary for ecological models and (b) supply data necessary for mathematical diffusion modeling to predict air quality impact.

2.2.1.2 Methods

The meteorological parameters listed in Table 2-3 are measured with standard meteorological sensors such as the wind speed and direction sensor, temperature sensor and relative humidity sensor. The output signal of these sensors is fed into the data acquisition and recording system discussed in section 2.1.

2.2.1.3 Results

The results of the meteorological measurements for February 1975 are listed in Table 2-4. Figures 2-3 to 2-6 summarize air temperature data. Figure 2-7 indicates temperature differences.

2.2.2 Upper Air Studies

2.2.2.1 Objectives

The objective of the upper air studies is to investigate large scale meteorological conditions such as upper inversion layers which can affect the lower atmospheric air pollution dispersion.

2.2.2.2 Methods

The upper air characteristics are divided into two segments;

(a) Upper air winds
(b) Upper air temperatures

The upper air winds are measured using pilot balloon tracking. The upper air temperatures are measured using an aircraft equipped with a fast response temperature measuring device.

2.2.2.3 Results

A sample of the results of the upper air studies is given in Figures 2-8 and 2-9.

2.2.3 Miscellaneous

2.2.3.1 Precipitation

2.2.3.1.1 Objectives

Precipitation is measured for use as a parameter in the ecological systems analysis and for determination of expected surface water increase.

TABLE 2-3

METEOROLOGICAL PARAMETERS MEASURED AT EACH SITE
(Lower Air to 200 Feet)

Parameters	Sites 1	2	3	4
Wind Speed (WS)				
60 Meter	X			
30 Meter	X			
10 Meter	X	X	X	X
Wind Direction (WD)				
60 Meter	X			
30 Meter	X			
10 Meter	X	X	X	X
Air Temperature (AT)				
60 Meter	X			
30 Meter	X			
10 Meter	X	X	X	X
Relative Humidity (RH)				
30 Meter	X			
Wind Sigma (σ_H)				
10 Meter	X			
Temperature Diff. (ΔT)				
(60-10 Meter)	X			
Solar Insolation	X			
Snow Course	X			
Evaporation	X			
Precipitation	X	X	X	X
Visibility	X			

TABLE 2-4

MONTHLY MINIMUM, MAXIMUM AND AVERAGE
VALUES OF METEOROLOGICAL PARAMETERS MEASURED ON RBOSP
TRACT C-a, PICEANCE CREEK BASIN, COLORADO
FEBRUARY 1975

Site 1

Parameter	Minimum	Maximum	Average
ΔT_{10-60} (°C)	- 2.08	1.15	0.17
WS_{60} (mph)	0.63	35.76	10.26
AT_{30} (°C)	-17.8	6.14	- 4.44
WS_{30} (mph)	0.56	32.19	8.76
WS_{10} (mph)	0.66	28.68	7.53
AT_{10} (°C)	-17.60	7.08	- 3.86
RH_{10} (%)	16.64	92.67	51.78

Site 2

Wind Speed (mph)	0.58	34.51	9.28
AT (°C)	-17.80	7.27	- 4.37

Site 3

Wind Speed (mph)	0.59	20.71	6.23
AT (°C)	-21.50	8.23	- 5.38

Site 4

Wind Speed (mph)	0.40	22.24	5.59
AT (°C)	-27.24	9.23	- 5.68

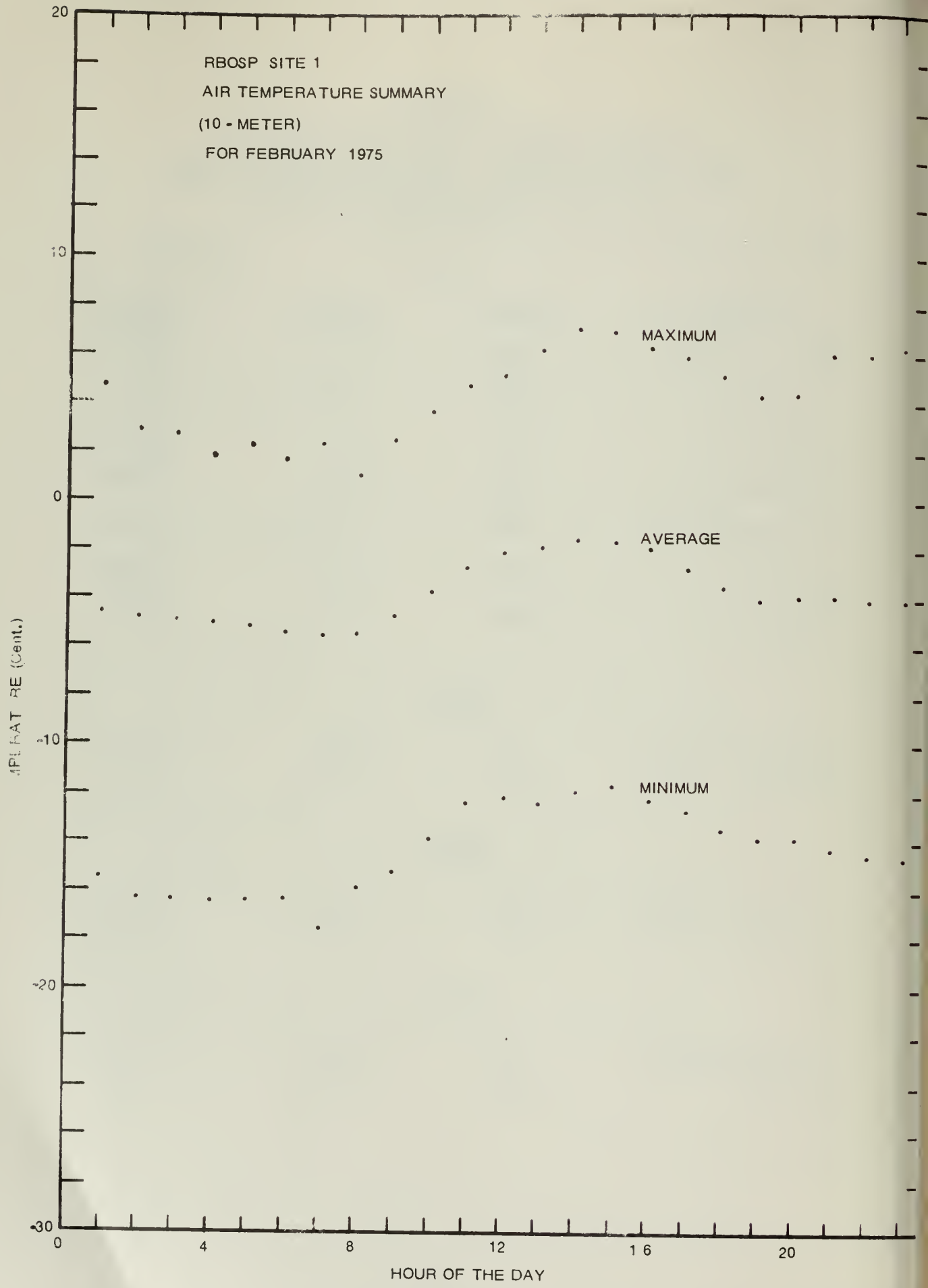


Figure 2-3. Air Temperature (10-Meter Level) at Site 1 by Hour of the Day for RBOSP, Tract C-a, February 1975.

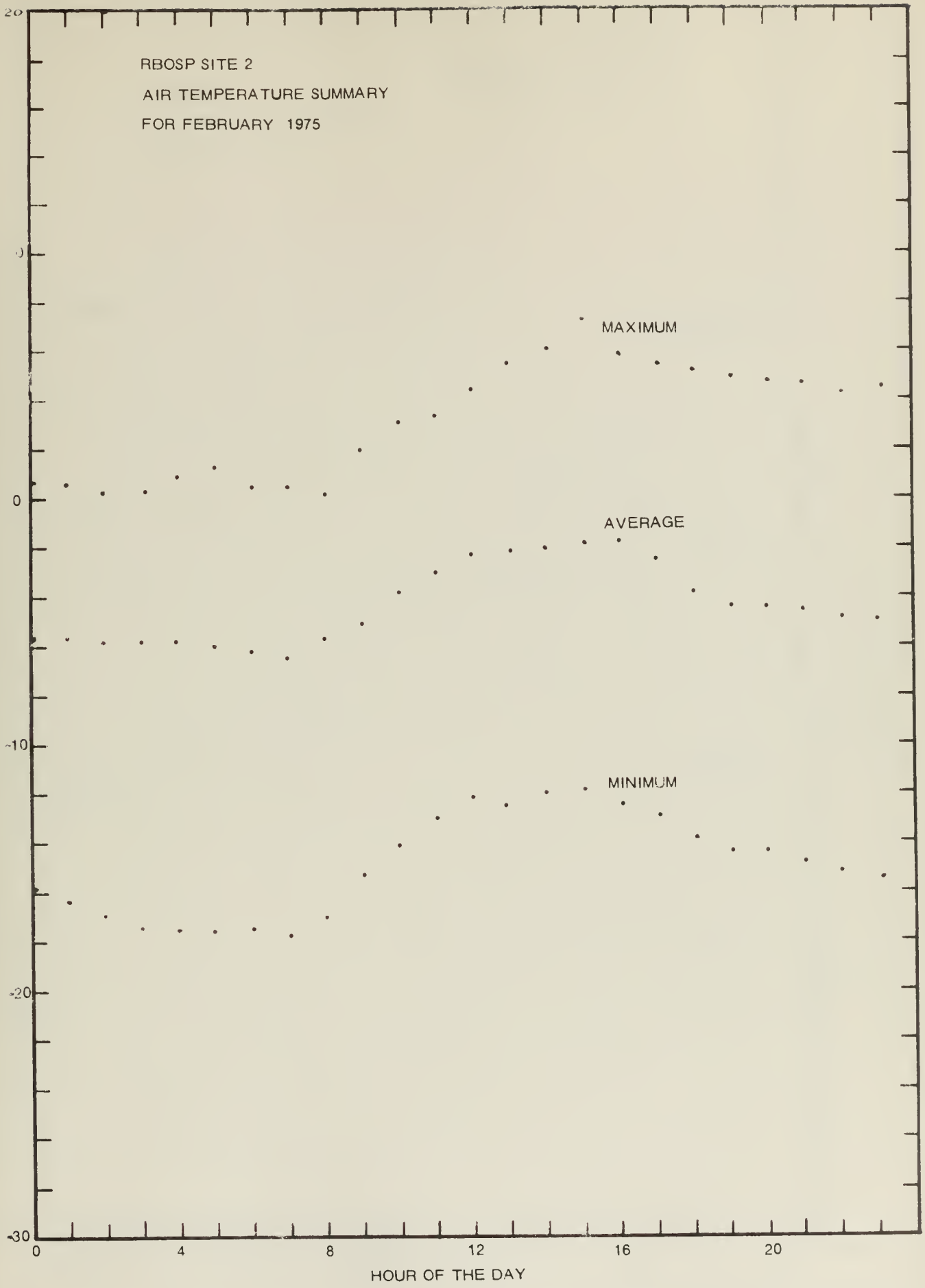


Figure 2-4. Air Temperature (10-Meter Level) at Site 2 by Hour of the Day for RBOSP, Tract C-a, February 1975.

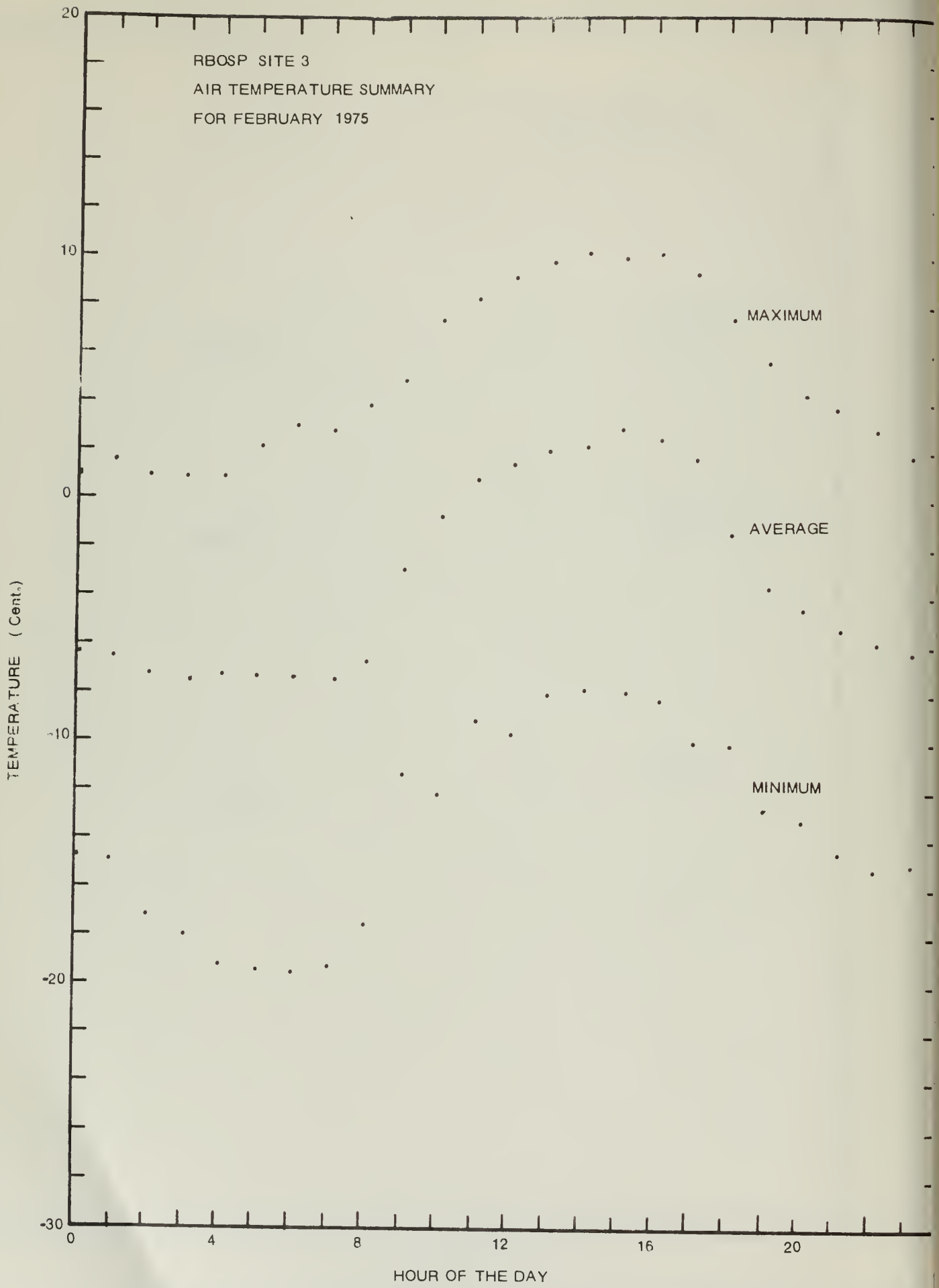


Figure 2-5. Air Temperature (10-Meter Level) at Site 3 by Hour of the Day for RBOSP, Tract C-a, February 1975

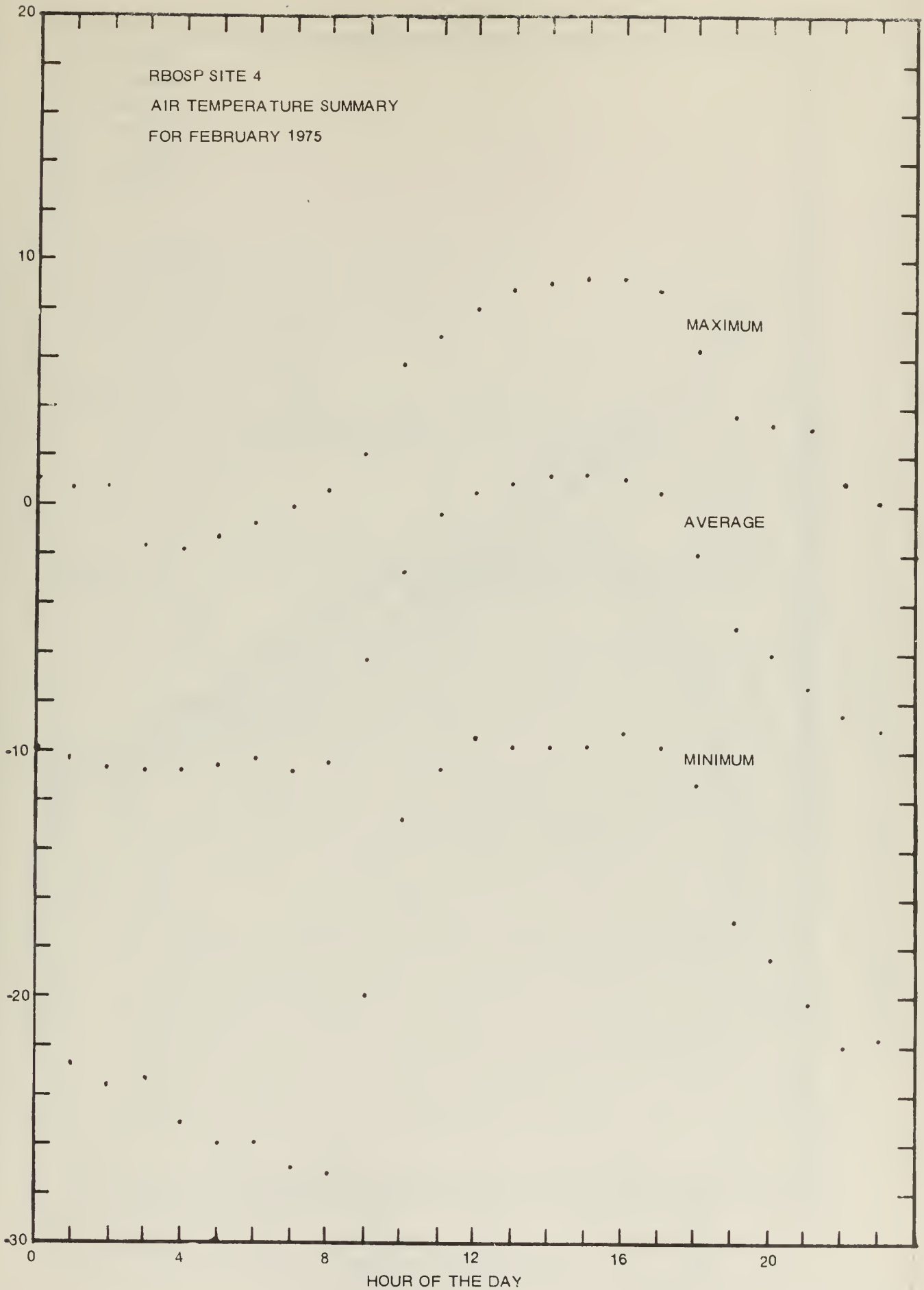


Figure 2-6. **Air Temperature** (10-Meter Level) at Site 4 by Hour of the Day for RBOSP, Tract C-a, February 1975

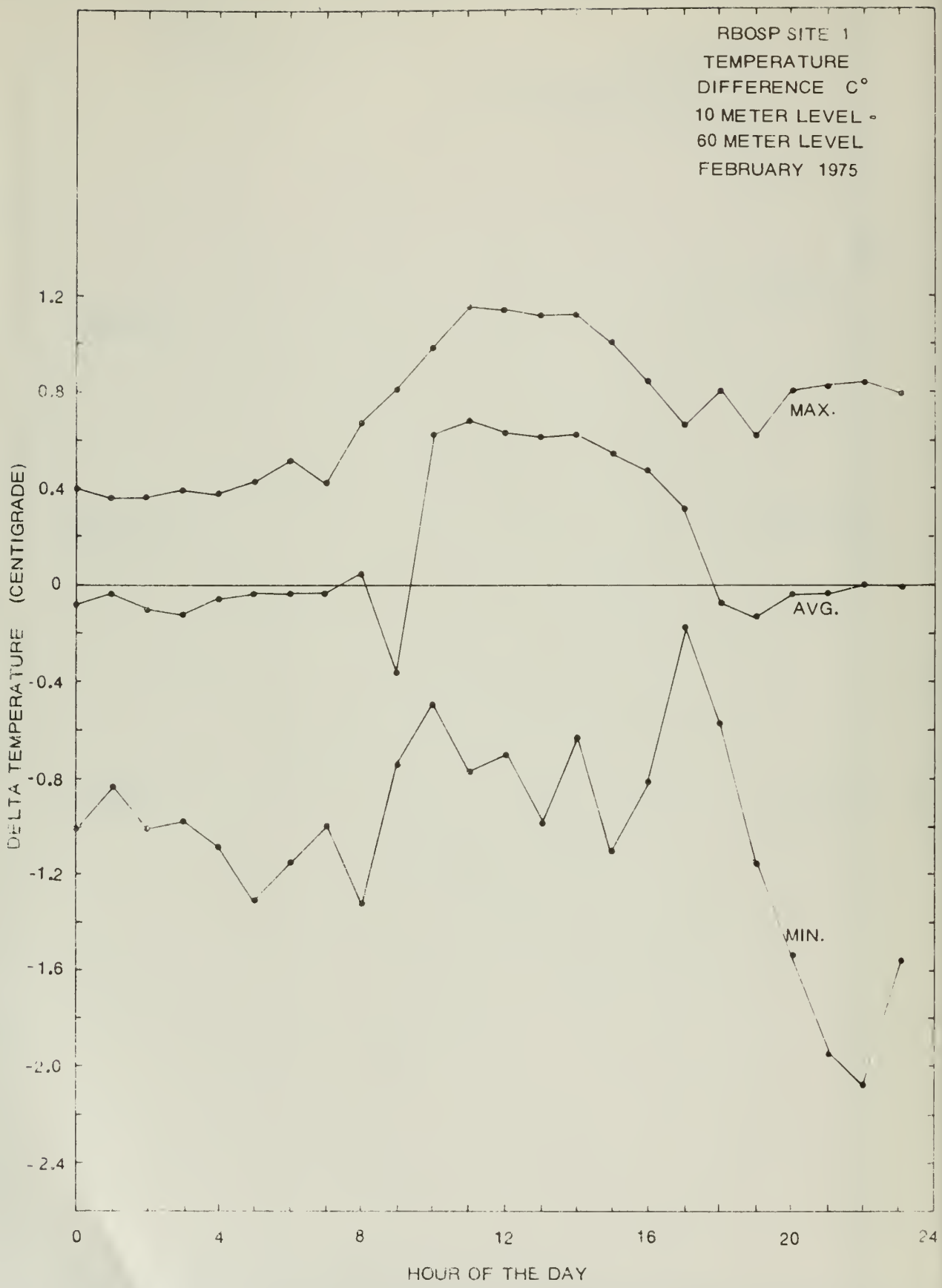


Figure 2-7. Temperature difference between 10- and 60-meter levels of the main meteorological tower by hour of day, RBOSP, Tract C-a.

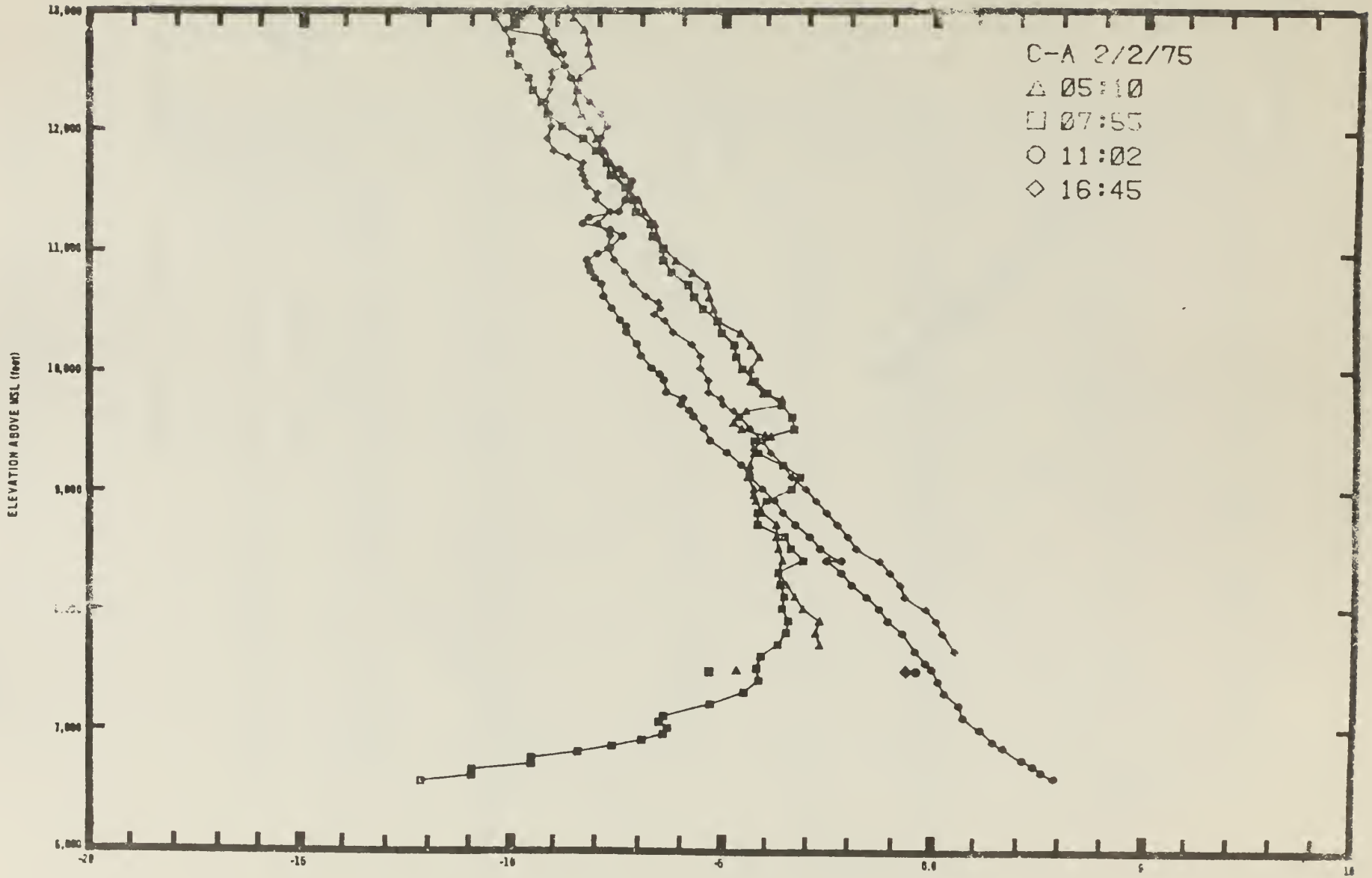
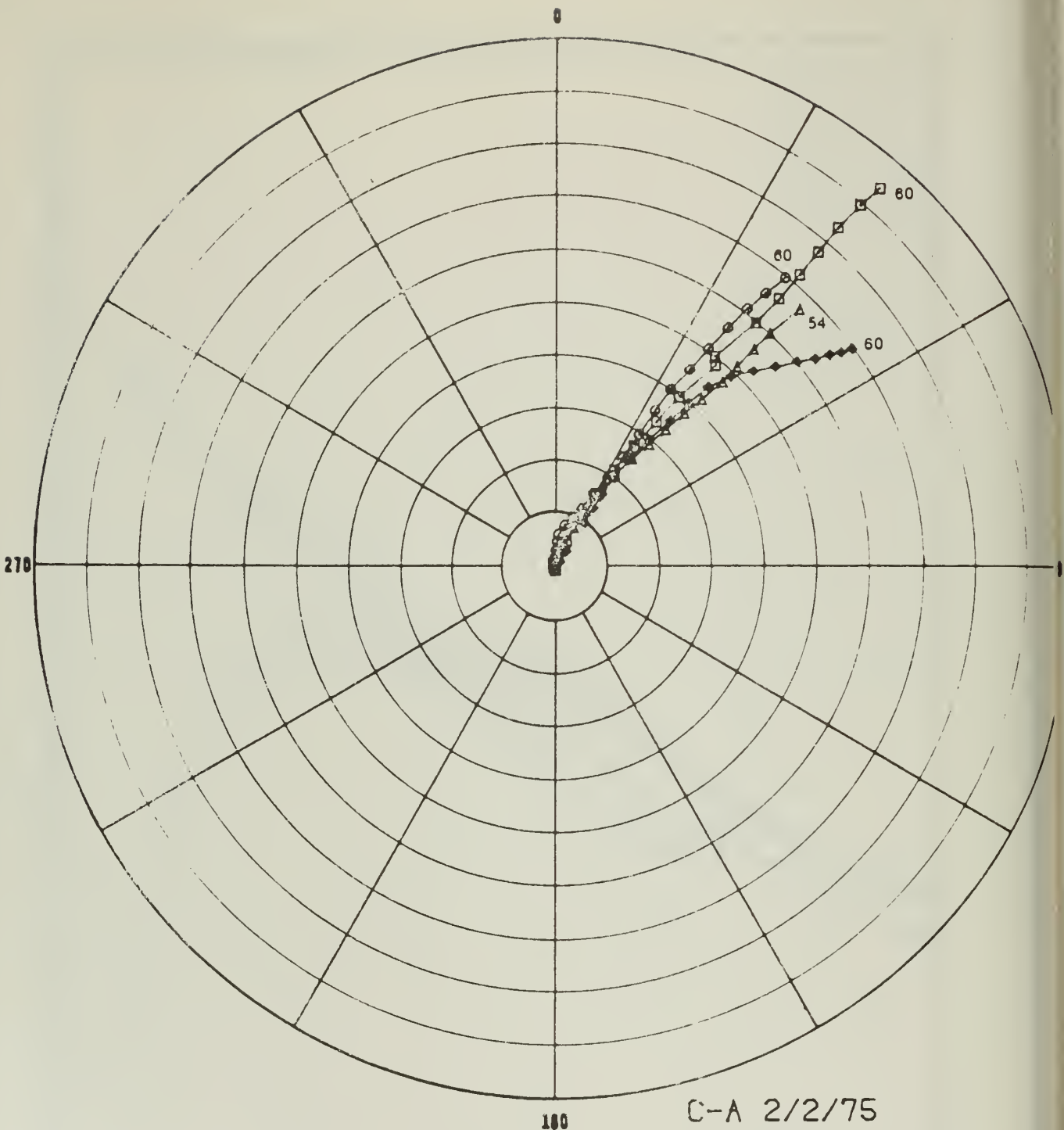


Figure 2-8
An Example of Vertical Temperature Profiles over Tract C-a, RBOSP in February 1975.



C-A 2/2/75

Time of Release △ 05:02 3000FT/DI
" " " □ 08:08 2000FT/DI
" " " ○ 11:04 3000FT/DI
" " " ◇ 16:54 3000FT/DI

Numbers in chart are in hundreds of feet.

Figure 2-9
Sample of PIBAL Trajectories over Tract C-a, RBOSP
February 1975.

2.2.3.1.2 Methods

Precipitation is measured with a heated tipping-bucket rain gauge.

2.2.3.1.3 Results

The results of the precipitation measurements and snow course are given in Tables 2-5 and 2-6.

2.2.3.2 Evaporation

2.2.3.2.1 Objectives

Evaporation is measured for use in ecological systems studies and to help determine surface water content over extended time periods.

2.2.3.2.2 Methods

Evaporation measurements are made with a calibrated evaporation tank.

2.2.3.2.3 Results

Evaporation measurements were not made during the quarter because of freezing conditions.

2.2.3.3 Solar Radiation

2.2.3.3.1 Objectives

Data on solar radiation are obtained to determine atmospheric stability which in turn is used to estimate diffusion parameters. It will also be used in ecological system studies.

2.2.3.3.2 Methods

Solar radiation is measured with a Scientific Association Pyro-heliometer which measures the total sun and sky radiation.

2.2.3.3.3 Results

The results of the solar radiation measurements are given in Figure 2-10.

2.2.3.4 Noise

Table 2-5

PRECIPITATION DATA FOR RIO BLANCO OIL SHALE PROJECT
TRACT C-a, PICEANCE BASIN, COLORADO
February 1975

DAY	SITE NO. 1 Hour	Amount	Day's Total	SITE NO. 2 Hour	Amount	Day's Total	SITE NO. 3 Hour	Amount	Day's Total	SITE NO. 4 Hour	Amount	Day's Total
02										16	.14	
										17	.03	
												.17
05										08	.02	
										09	.03	
												.05
10				13	.02		15	.01		12	.05	
										14	.02	
						.02			.01			.07
14	20	.01		13	.01		08	.01		13	.01	
							09	.01				
							12	.01				
							13	.01				
			.01			.01			.04			.01
16										19	.01	
										20	.01	
												.02
17				08	.01							
						.01						
TOTAL PRECIP.			.01			.04			.05			.32

Note: Amount expressed in inches of water.

TABLE 2-6

SNOW COURSE MEASUREMENT FOR RIO BLANCO OIL SHALE PROJECT
TRACT C-a, PICEANCE BASIN, COLORADO
February 1975

Date of Sample	Total Snow Depth (inches)	Sample (inches of H_2O)
2/1/75	7.5"	.15"
2/5/75	4.5"	.10"
2/12/75	5.5"	.20"
2/16/75	5.0"	.20"
2/23/75	3.5"	.10"

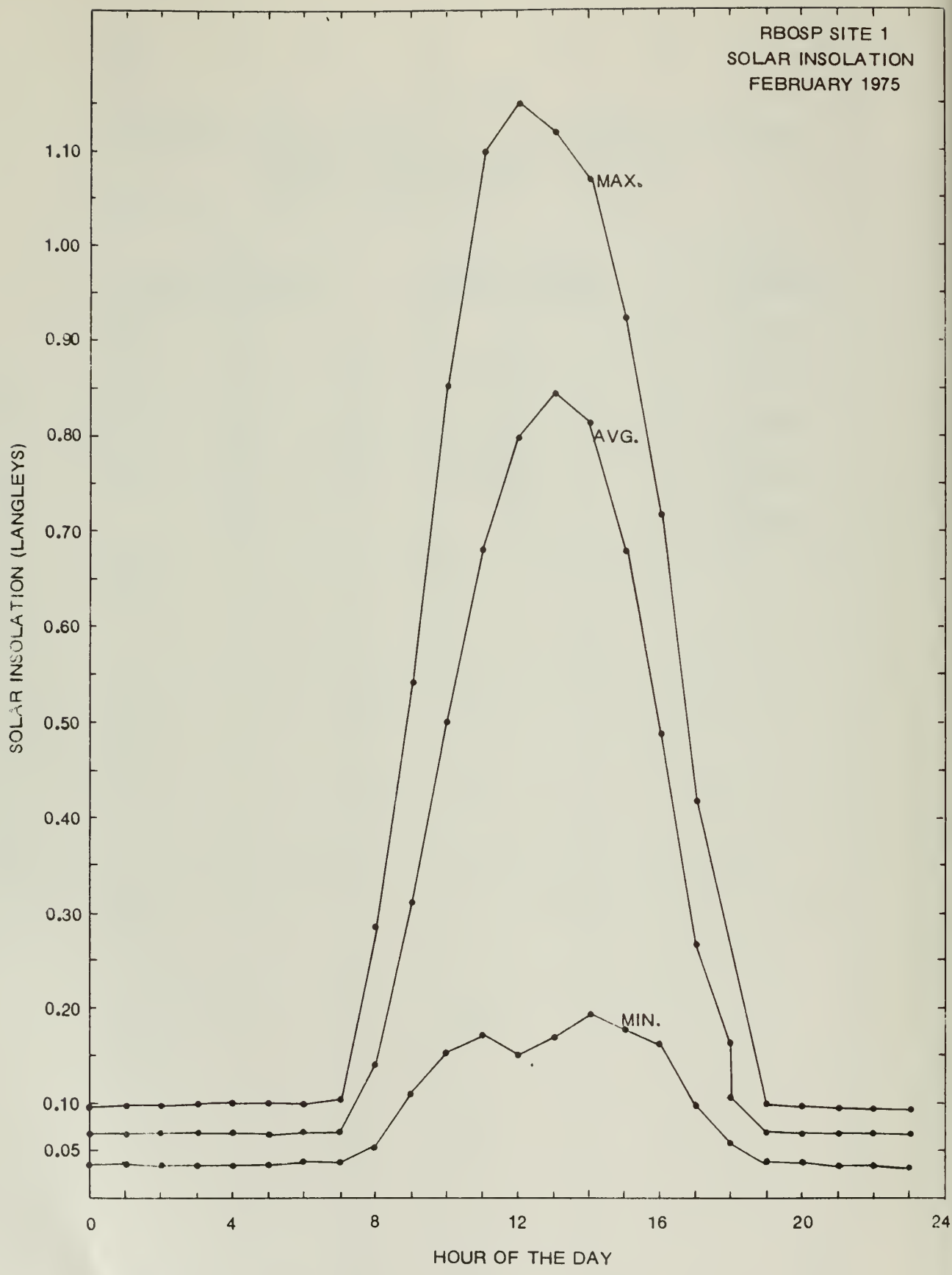


Figure 2-10. Solar Radiation at main meteorological tower by hour of day for February 1975, RBOSP, Tract C-a.

2.2.3.4.1 Objectives

The current (baseline) noise level is determined to establish a reference point with which future noise levels can be compared.

2.2.3.4.2 Methods

Ambient noise level at each trailer location for Tract C-a will be measured twice per year; one in midsummer and the other in midwinter. The measurements will be performed over a period of 11 days at each installation.

2.2.3.4.3 Results

Noise measurements will be taken in the spring 1975.

2.2.3.5 Visibility

2.2.3.5.1 Objectives

The objectives of the visibility measurements are to determine what might be considered "normal" visibility under various meteorological conditions and to help identify effects of human activity on visibility.

2.2.3.5.2 Methods

Visibility measurements are made according to the National Weather Service technique, backed up with polaroid photographs in the four cardinal directions.

2.2.3.5.3 Results

During most of the study period the ground was either snow covered or wet. The visibility was essentially unlimited with virtually no fugitive dust. Visibility data are given in Table 2-7.

2.2.3.6 Tracer Studies

Models used to predict ground concentrations of pollutants as a function of meteorological conditions are not well verified empirically over rugged terrain such as that at Tract C-a. Trace diffusion studies will be performed to verify which model is most applicable to the specific topography at Tract C-a.

TABLE 2-7

VISIBILITY DATA FOR RIO BLANCO OIL SHALE PROJECT
TRACT C-a, PICEANCE BASIN, COLORADO
February 1975

Date of Sample	Time of Sample	Precipitation in last 24 hours (in)	Prevailing Visibility (mi) N	E	S	W	Comments
2/12/75	1200	0	>150	150	150	150	High light clouds; mild winds from SW
2/16/75	missing	.01	100	100	100	100	None
2/20/75	0830	0	2	2	2	2	Snowing, winds from W at approx. 20 mph
2/25/75	0900	0	150	150	150	150	Clouds to East at 150 mi; winds from N at 1-2 mph
2/28/75	1400	0	100	100	100	100	Scattered clouds throughout horizon; winds from S and W at 9-10 mph

2.3 Terrestrial Studies

The terrestrial program is designed to determine baseline parameters on vegetation, small mammals, large mammals, mammalian predators, avifauna, reptiles, amphibians and invertebrates. A variety of studies is performed to determine these parameters (Table 2-8). These will meet lease stipulations and provide data necessary to describe the ecosystem.

2.3.1 Vegetation

2.3.1.1 Objectives

The vegetation investigations are designed to meet lease requirements asking for data on the distribution, abundance and density of plants in the area. This is accomplished quantitatively and qualitatively through the description and mapping of the major vegetation types, and collection and identification of plant voucher specimens. These investigations provide phytosociological information essential to the understanding of local ecosystem structure and provides a foundation for future comparative studies on Tract C-a and the surrounding area.

2.3.1.2 Methods

Vegetational analyses involve measurement of phytosociological parameters along line-strip quadrants, plant specimen collections, identification and measurement of herbage yield within exclosures (Table 2-8).

A total of ninety-six, 60 x 6m transects has been placed in each of the major vegetation types located both on and off Tract C-a (Figure 2-11). Of these, 38 are permanent and sampled in the same location during all sampling periods. These transects provide data on seasonal and annual vegetational changes. The remaining 58 non-permanent transects are relocated after each sample period to obtain a more reliable statistical representation of each vegetation type by increasing the area sampled both on and off the tract.

2.3.1.3 Results

Ten different vegetation types (Table 2-9) in 96 separate locations (Figure 2-11) were sampled on and near Tract C-a during October 1974. Random and permanent transect data were combined to provide an overall regional view of the general phytosociological characteristics common to each of the vegetation types. The total number of species, total percent ground cover, total density, and predominant species for each stratum of each of the vegetation types are presented in Table 2-9. Ninety-three species were encountered during the October sampling period (Table 2-10).

Table 2-8

SUMMARY OF RIO BLANCO OIL SHALE PROJECT
TRACT C-a TERRESTRIAL SAMPLING PROGRAMS
Piceance Basin, Colorado

Group Sampled	Objectives	Methodology	No. Sample Sites	Dates Sampled
Vegetation	Phytosociological relationships, species Taxonomy	Line-strip/quadrat	96	Oct.10-18,1974
Aerial Flights	Mapping/Distribution	Plant collection Remote sensing (CIR)	Area Coverage Area Coverage	Routinely Summer, 1975
Exclosures	Grazing pressure of large herbivores and rodents, productivity	Ocular/clipped plot-grasses; size, condition and % available to browse-shrubs; canopy cover-trees	1	Construction phase
Small Mammals	Population studies, inventory, habitat preference	Live trapping grids	20	Oct.19-24,Dec.7-1 1974.
		Snap trapping	7	Nov.9-14,Dec.7-11 1974.
	Habitat preference	Pitfall trapping	6	Oct.21-24,Dec.9-1 1974.
	Abundance, distribution	Night spotlighting	30mi.route	Nov.11,13,1974,Fe 10,12,1975.
	Dietary preference	Laboratory analysis		Nov.,Dec.,1974,Fe 1975.
	Inventory	Mist netting		Summer, 1975

Table 2-8 (Continued)

Group Sampled	Objectives	Methodology	No. Sample Sites	Dates Sampled
Large Mammals	Winter deer distribution, abundance	Aerial flights	13 transects	Nov.8,21,Dec.9, 30,1974,Jan.14, Feb.1,12,1975.
	Deer sex and age ratios	Helicopter counts	Area coverage	Dec.27,1974
	Elk and feral horse distribution	Aerial flights	9 transects	Nov.8,Dec.30,1974
Mammal Predators	Inventory, distribution	Scent stations	30	Nov.11-15,1974, Feb.10-14,1975
	Coyote distribution	Siren Elicited Howling Response	11	Nov.11,13,1974, Feb.10,12,1975
Other Mammal Studies	Inventory, distribution, abundance	Winter track count transects	8	Feb.13-21,1975
	Mammal abundance, distribution	Signs, dens, scat counts		Opportunistic
Avifauna Songbirds Gamebirds	Inventory, distribution, abundance habitat preference, breeding areas	Emlen Strip Transects Species transect counts	20	Oct.11-14,Dec.14-16,1974,Feb.16-21, 1975.
Waterfowl	Inventory, distribution	Waterfowl census	1	Oct.11,12,14,1974

Table 2-8 (Continued)

Group Sampled	Objectives	Methodology	No. Sample Sites	Dates Sampled
Raptors	Inventory, distribution	Owl night counts	30 mi. route	Dec 16, 17, 1974
		Aerial transects ground counts	Area coverage	Nov 21, Dec 30,1974 Jan 14, Feb 1, 1975
Reptiles and Amphibians	Inventory, distribution	Transects Grids Breeding Site Visits	5 2 Opportunistic	Spring, 1975
Invertebrates	Inventory, distribution	Sweep nets D-Vac units	5 5	Spring, 1975
Domestic Livestock	Distribution, abundance	Aerial census	9 transects	Nov 8,Dec 30, 1974
Rare & Endangered Species	Occurence, importance	Part of other programs	Area coverage	Opportunistic

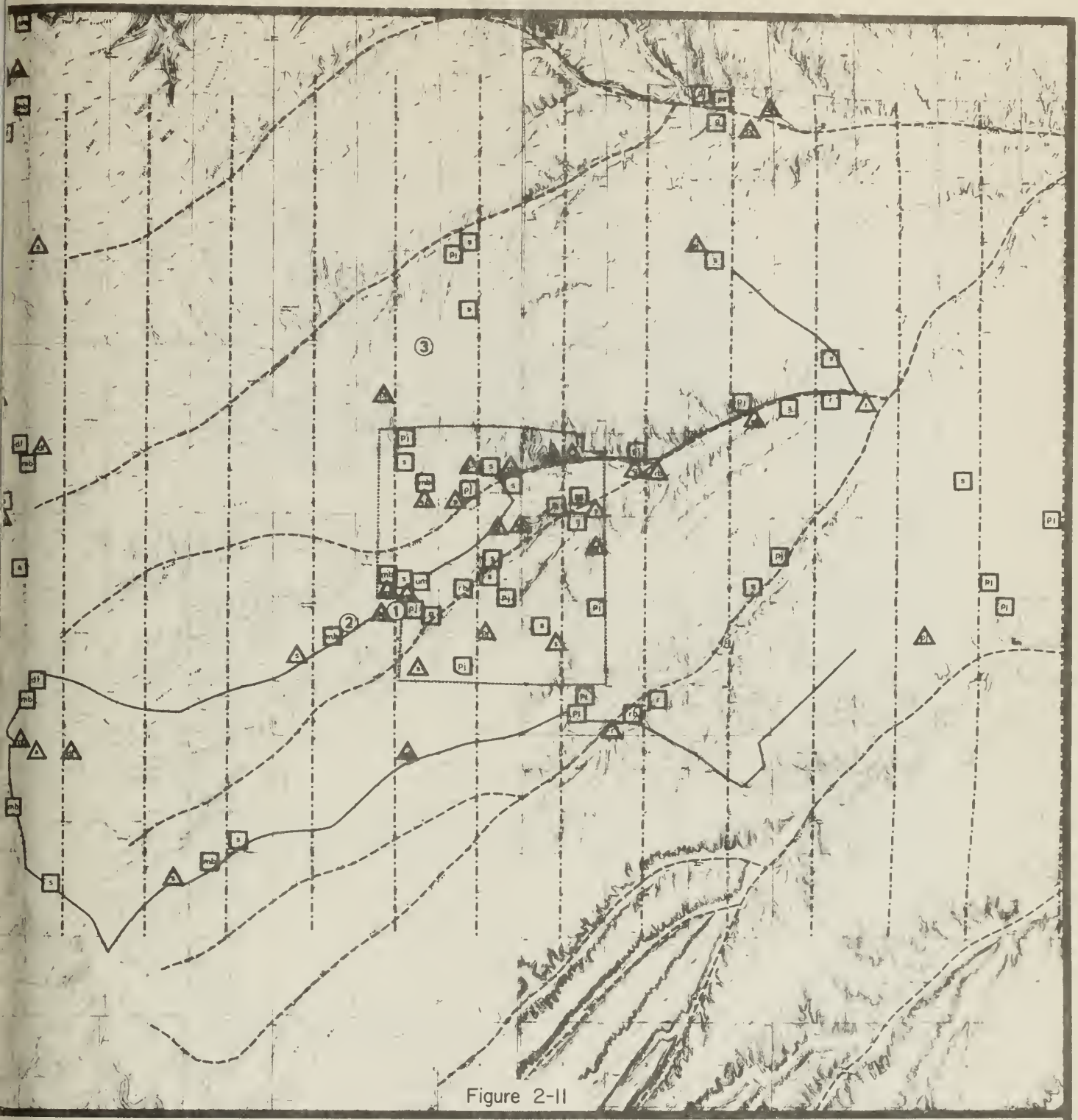


Figure 2-11

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

LIMNETICS, INC.
Denver, Colorado

RAPTOR SURVEY & VEGETATION SAMPLING SITES

- north-south raptor transects (aerial)
- canyon raptor aerial transects
- owl ground count transect
- exclosure sites (1-3)
- permanent sampling sites
- temporary sampling sites of Oct. 1974

a	aspen	rb	rabbitbrush
df	douglas fir	ss	shadscale
mb	mixed brush	g	greasewood
pj	pinyon-juniper	r	riparian
s	sagebrush	um	upland meadow

N

MILES
0 1/2 1 2

2/75

Table 2-9 Summary of some phytosociological characteristics of ten different vegetation types sampled on Tract C-a and the surrounding area for the Rio Blanco Oil Shale Project, October, 1974

Vegetation Type/Stratum	Total Number of Species	Total % Ground Cover	Total Density Per Hectare	Predominant Species
Aspen				
Herb	28	29.0	1/	Carex sp., Bromus sp.
Shrub	9	42.8	13,340 2/	Symphoricarpos sp., Amelanchier sp., Populus tremuloides
Tree	1	33.5	479	Populus tremuloides
Douglas fir				
Herb	18	21.5	1/	Carex sp., Aster sp., Galium boreale
Shrub	8	41.0	12,055 2/	Symphoricarpos sp., Amelanchier sp., Prunus sp.
Tree	2	70.7	518	Pseudotsuga menziesii, Populus tremuloides
Upland meadow				
Herb	33	22.9	1/	Agropyron trachycaulum, Poa sp.
Shrub	3/	3/	3/	
Tree	3/	3/	3/	
Mixed brush				
Herb	36	21.8	1/	Agropyron trachycaulum, Carex sp., Festuca sp., Poa sp.
Shrub	12	41.7	18,622 2/	Amelanchier sp., Symphoricarpos sp., Artemisia tridentata
Tree	2	1.0	11.1	Juniperus osteosperma, Pinus edulis

Table 2-9 (Continued)

Vegetation Type/Stratum	Total Number of Species	Total % Ground Cover	Total Density Per Hectare	Predominant Species
Pinyon-Juniper				
Herb	63	5.4	1/	Agropyron trachycaulum, Festuca sp., Poa sp.
Shrub	15	8.8	3,730.5	Artemisia tridentata, Pinus edulis, Purshia tridentata, Chrysothamnus sp.
Tree	2	21.5	295	Juniperus osteosperma, Pinus edulis
Sagebrush				
Herb	53	12.6	1/	Agropyron trachycaulum, Poa sp., Festuca sp.
Shrub	13	28.8	13,214 2/	Artemisia tridentata, Chrysothamnus sp., Amelanchier sp.
Tree	0 3/	0 3/	0 3/	
Shadscale				
Herb	13	22.6	1/	Agropyron trachycaulum, Oryzopsis hymenoide Gutierrezia sp.
Shrub	11	15.5	8,444	Atriplex confertifolia, Chrysothamnus sp., Artemisia tridentata, Artemisia frigida
Tree	1	<1.0	13.9	Juniperus osteosperma
Greasewood				
Herb	11	5.2	1/	Agropyron trachycaulum, Bromus tectorum, Lepidium sp.
Shrub	6	43.5	15,223	Sarcobatus vermiculatus, Artemisia tridentata
Tree	0 3/	0 3/	0 3/	

Table 2-9 (Continued)

Vegetation Type/Stratum	Total Number of Species	Total % Ground Cover	Total Density Per Hectare	Predominant Species
Rabbitbrush				
Herb	11	11.5	0[1]/	Elymus cinereus, Agropyron sp., Poa pratensis
Shrub	4	40.8	9,055	Chrysothamnus nauseosus, Artemisia tridentata
Tree	0[3]/	0[3]/	0[3]/	
Riparian				
Herb	37	53.5	1/	Scirpus sp., Cyperus sp., Unidentified grass
Shrub	0[3]/	0[3]/	0[3]/	
Tree	0[3]/	0[3]/	0[3]/	

1/ Density is not determined for herbaceous layer.

2/ Includes stem counts of Amelanchier.

3/ Strata not present or not encountered during sampling.

Table 2-10 Tree, shrub, and herbaceous vegetation species encountered in the vicinity of Tract C-a for the Rio Blanco Oil Shale Project, October, 1974

Scientific Name	Common Name
TREES	
Juniperus osteosperma (utahensis)	Utah juniper
Pinus edulis	Pinyon pine
Populus tremuloides	Quaking aspen
Pseudotsuga menziesii (taxifolia)	Common Douglas fir
SHRUBS	
Acer glabrum	Rocky Mountain maple
Amelanchier sp.	Serviceberry
Artemisia frigida	Fringed sagewort
Artemisia tridentata	Basin big sagebrush
Atriplex canescens	Fourwing saltbush
Atriplex confertifolia	Shadscale saltbush
Cercocarpus montanus	True mountain mahogany
Chrysothamnus nauseosus	Rubber rabbitbrush
C. vicidiflorus	Douglas rabbitbrush
Ephedra sp.	Mormontea
Eurotia lanata	Common winterfat
Gutierrezia sp.	Snakeweed
Prunus sp.	Chokecherry
Purshia tridentata	Antelope bitterbrush
Quercus gambelii	Gambel oak
Rhus sp.	Sumac
Ribes sp.	Currant
Rosa sp.	Rose
Sarcobatus vermiculatus	Black greasewood
Symphoricarpos sp.	Snowberry
Tetradymia canescens	Gray horsebrush
HERBACEOUS SPECIES	
Achillea lanulosa	Western yarrow
Agropyron cristatum	Crested wheatgrass
A. smithii	Western wheatgrass
A. spicatum	Bluebunch wheatgrass
A. trachycaulum	Slender wheatgrass

Table 2-10 (Continued)

Scientific Name	Common Name
	HERBACEOUS SPECIES (Continued)
Ambrosia sp.	Ragweed
Androsace sp.	Rockjasmine
Angelica sp.	Angelica
Antennaria sp.	Pussytoes
Haplopappus sp.	Goldenweed
Haplopappus spinulosus	Ironplant goldenweed
Arctostaphylos sp.	Manzanita
Arenaria sp.	Sandwort
Aster sp.	Aster
Astragalus sp.	Milkvetch
Balsamorhiza sp.	Balsamroot
Bouteloua gracilis	Blue grama
Bromus ciliatus	Fringed brome
B. marginatus	Mountain brome
B. tectorum	Cheatgrass brome
Carex sp.	Sedge
Chaenactis sp.	Dustymaiden
Chenopodium sp.	Goosefoot
Cryptantha sp.	Cryptantha
Cyperus sp.	Flatsedge
Descurainia sp.	Tansymustard
Draba sp.	Draba
Elymus sp.	Wildrye
Equisetum sp.	Horsetail
Erigeron sp.	Fleabane
Eriogonum sp.	Wildbuckwheat
Eriogonum alatum	Wing wildbuckwheat
Euphorbia sp.	Spurge
Festuca sp.	Fescue
Fragaria sp.	Strawberry
Galium boreale	Northern bedstraw
Geranium sp.	Geranium
Gilia sp.	Gilia
Hymenoxys sp.	Actinea
Kochia scoparia	Fireweed summercypress

Table 2-10 (Continued)

Scientific Name	Common Name
	HERBACEOUS SPECIES (Continued)
Koeleria cristata	Prairie junegrass
Lappula sp.	Stickseed
Lepidium sp.	Pepperweed
Lithospermum sp.	Gromwell
Lupinus sp.	Lupine
Mentzelia sp.	Mentzelia
Mertensia sp.	Bluebells
Muhlenbergia sp.	Muhly
Oenothera sp.	Evening primrose
Opuntia polyacantha	Plains pricklypear
Oryzopsis hymenoides	Indian ricegrass
O. lamberti	Lambert loco
Penstemon caespitosus	Mat penstemon
Penstemon strictus	Rocky Mountain penstemon
Phlox sp.	Phlox
Poa interior	Inland bluegrass
P. pratensis	Kentucky bluegrass
P. secunda	Sandberg bluegrass
Ranunculus sp.	Buttercup
Rorippa sp.	Cress
Scirpus sp.	Bulrush
Sitanion hystrix	Bottlebrush squirreltail
Sphaeralcea sp.	Globemallow
Stipa sp.	Needlegrass
Stipa comata	Needleandthread
Thalictrum sp.	Meadowrue
Thermopsis montana	Mountain thermopsis
Viola sp.	Violet

2.3.2 Grazing Exclosures

2.3.2.1 Objectives

The grazing exclosures established on and near Tract C-a are designed to demonstrate and monitor vegetation responses to the exclusion of particular groups of grazing or browsing herbivores. Various forage species can be expected to respond to protection according to their position in the hierarchy of consumer preferences. Thus, the most desirable components of the plant community should react most dramatically to a release from the restraints exercised upon them by herbivores.

Quantitative, qualitative and photoplot study techniques, will be utilized to measure responses. The above techniques, will focus on the forage production resulting from the degree or quality of protection being afforded.

Careful evaluation of data obtained during this study may reveal several important aspects of ecosystem interactions. It may be possible to address plant species preferences for each class of herbivore. Determination of the relative importance of individual plant species to wildlife, livestock and feral horses will facilitate the definition of priorities for land rehabilitation and revegetation.

2.3.2.2 Methods

Each exclosure encompasses 1.2 ha measuring 191 x 63 m (Figure 2-2). An exclosure contains three compartments or sections, each constructed to prevent access by particular groups of herbivores. The largest compartment excludes domestic livestock and feral horses, but allows free access to big game and small mammals. The second compartment excludes big game and livestock, but not smaller mammals. The third compartment is designed to eliminate all mammalian herbivores. In addition, one study area commensurate in size to the largest exclosure compartment, is established outside each exclosure. This comprises the control plot subject to normal foraging.

The grazing exclosures and control sites will be sampled during August 1975 and 1976. Clipped plot methods will be utilized for the grass-forb stratum. Maximum shrub height, mean diameter, percent of shrub alive and percent browse available will be recorded for the shrub stratum. In addition, tree canopy will be recorded for the tree stratum.

2.3.3 Small Mammals

2.3.3.1 Objectives

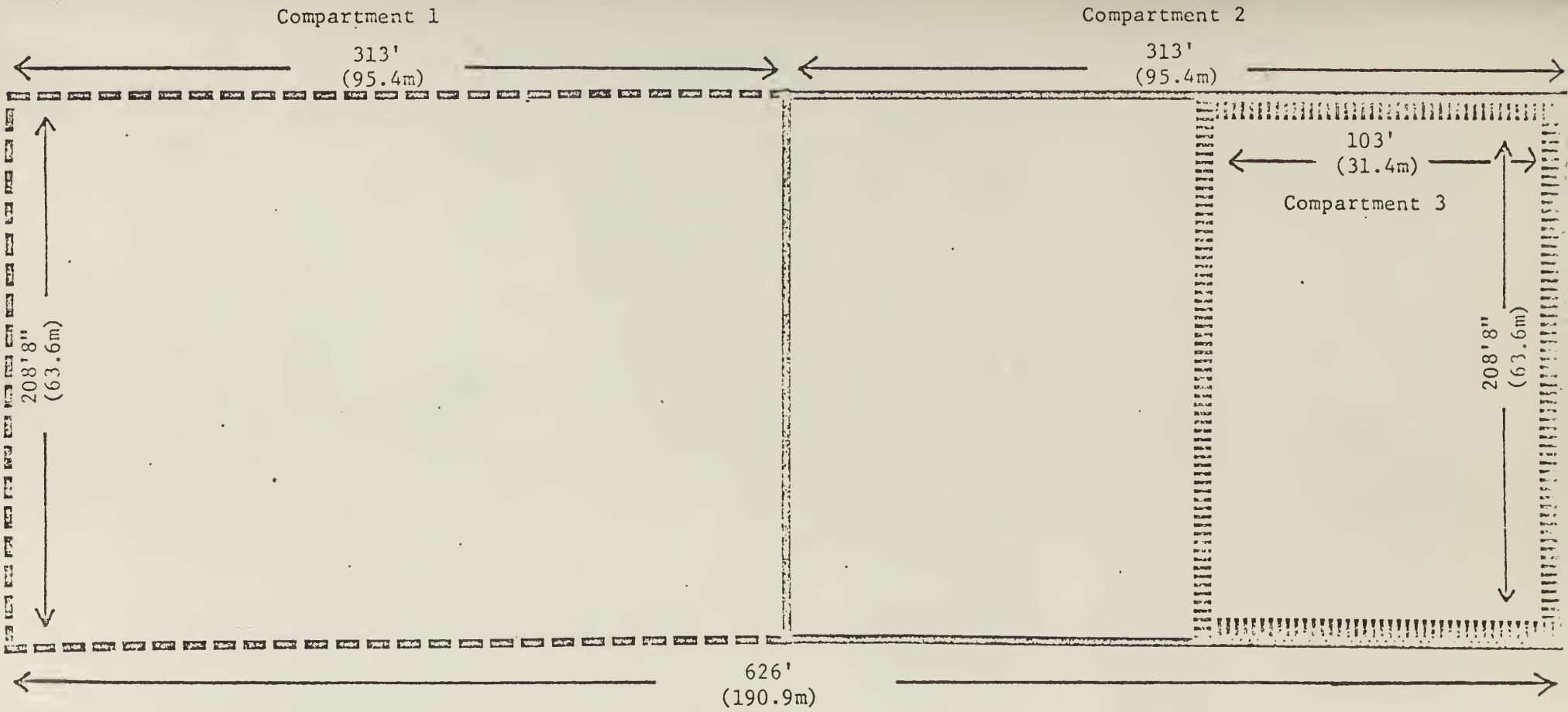


Figure 2-12 Design of the grazing exclosures used for the Rio Blanco Oil Shale Project, Tract C-a.

The objectives of the small mammal program are to census species present in and adjacent to Tract C-a, and determine diversity, distribution and densities (as stipulated in the lease), within habitat types common to the area. Seasonal activity, reproductive effort, trophic relationships and important species will also be addressed.

2.3.3.2 Methods

Methods employed include: live trapping and marking, limited snap trapping and laboratory analysis, pitfall trapping, night spotlight censusing, mist-netting (for species not readily obtained by standard live trapping techniques) and field observations (Table 2-8).

2.3.3.3 Results

Ten species of rodents (Table 2-11) representing two families were taken from 20 separate live trapping grids (Figure 2-13) in October and December 1974. A total of 1,240 small mammals was taken during the two sampling periods. The deer mouse (Peromyscus maniculatus) was the most common mammal sampled and was present in all habitat types sampled. The greatest number of different rodent species was recorded in sagebrush and pinyon-juniper vegetation types.

Unfavorable weather conditions and reduced small mammal activity resulted in 20 specimens in November and 8 specimens in December (far below the desired sample size) for stomach analysis. The results of the analysis indicated that seeds comprise at least 67% of the total diet of the deer mouse and the least chipmunk (Eutamias minimus) during the winter, while succulent vegetation parts appear to be the desired food (79%) of the montane vole (Microtus montanus). However, the data are insufficient to permit the formulation of firm conclusions concerning small mammal food preferences in the vicinity of Tract C-a at this time.

Pitfall trapping was conducted within six different vegetation types during October 21-24 and December 9-12, 1974. Two shrew species, masked shrew (Sorex cinereus) and Merriam's shrew (Sorex merriami) were documented.

Night spotlight censuses (Figure 2-13) were conducted on November 11 and 13, 1974 and February 10 and 12, 1975. At least two species of lagomorphs (rabbits and hares), the white-tailed jackrabbit (Lepus townsendii) and the cottontail (Sylvilagus sp.) were observed during the censuses.

Since bats cannot be censused by the methods employed in other studies, they will be captured in mist nets placed above ponds in the area. The nets will be operated for four consecutive nights in June and August. Pertinent data will be recorded and the bats will be released.

TABLE 2-11

TOTAL NUMBER OF ALL SMALL MAMMAL SPECIES CAPTURED ON ALL LIVE TRAPPING GRIDS
FOR THE RIO BLANCO OIL SHALE PROJECT
October and December, 1974

Family Common Name (Species)	Trapping Period I (October 19-24, 1974) Total	Trapping Period 2 (December 7-11, 1974) Total
Sciuridae (Squirrels, ground squirrels, chipmunks)		
Least chipmunk (*Eutamius minimus*)	406	1
Colorado chipmunk (*Eutamius quadrivittatus*)	45	3
Golden mantled ground squirrel (*Spermophilus lateralis*)	3	0
Cricetidae (New World mice and rats)		
Deer mouse (*Peromyscus maniculatus*)	440	166
Pinon mouse (*Peromyscus truei*)	15	6
Bushy-tailed woodrat (*Neotoma cinera*)	7	0
Gapper's Red-backed vole (*Clethrionomys gapperi*)	22 1/	18 1/
Montane vole (*Microtus montanus*)	0	6 1/
Long-tailed vole (*Microtus longicaudus*)	36 1/	42 1/
Sagebrush vole (*Lagurus curtatus*)	8 1/	16 1/
Totals	982	258

1/ Unable to make positive determination of sex in the field.

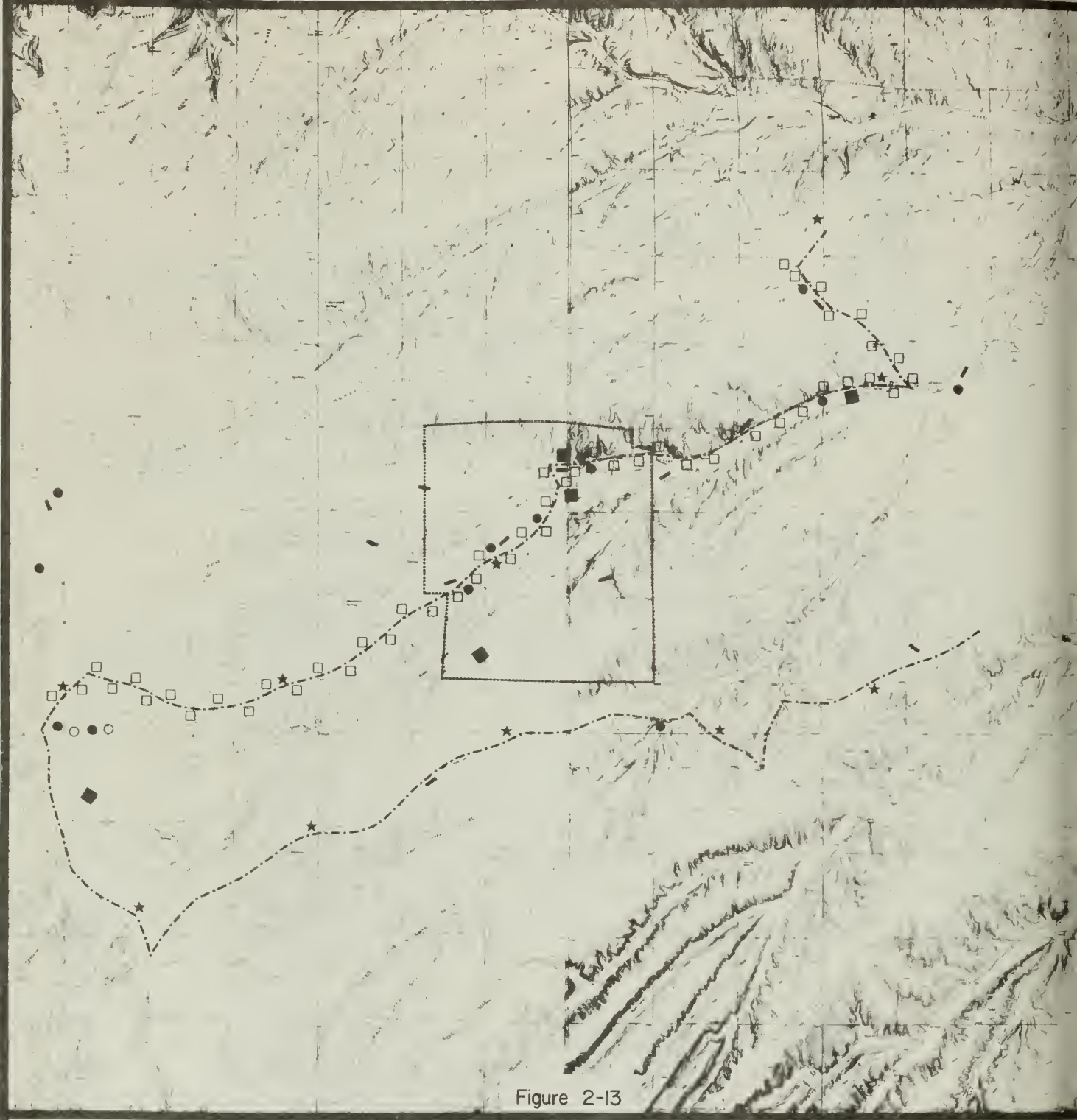


Figure 2-13

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

MAMMAL SAMPLING LOCATIONS

★ coyote howling stations

□ predator scent-stations

-·-·- spotlight census route

● pitfall trapping stations

live trapping grids

— 0.81 ha grids

○ 1.35 ha grids

■ 7.29 ha grids

MILES

0 1/2 1

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2.3.4 Large Mammals

2.3.4.1 Objectives

Large mammal investigations are designed to determine the distribution, relative abundance and population characteristics of mule deer (Odocoileus hemionus), elk (Cervus canadensis) and feral horses (Equus caballus) on and in the vicinity of Tract C-a on a seasonal basis. Investigations are also being conducted to determine relative habitat use of portions of the study area and seasonal movements (migrations) of mule deer as specified by the lease.

2.3.4.2 Methods

Large mammals are censused with fixed-wing aircraft (Figure 2-14) to determine distribution and abundance. In addition, personnel in helicopter will determine the sex ratio of mule deer.

2.3.4.3 Results

Mule deer winter counts were conducted on November 8 and 21, December 9 and 30, 1974, January 14 and February 1 and 12, 1975. The number of mule deer observed (Table 2-12) showed a seasonal trend with a low in November, peak in December and a subsequent decline in January continuing through February.

In November, the majority of the deer was located on Tract C-a and to the west; however, with the arrival of snow and colder weather, the herd shifted to the east. Presently, their distribution is located well east of the tract.

On December 27, 1974, sex ratios were recorded. The route surveyed includes Tract C-a, west census area, Stake Springs Draw and 84 Mesa. The data indicated a buck-doe ratio of 1:5.7 and doe-fawn ratio of 1:0.92.

On November 8, 1974 and December 30, 1974, aerial surveys were conducted to survey both elk and feral horses. During the initial flight, no elk were observed. However, 108 feral horses were recorded. On December 30, 1974 survey, no elk were observed, but 86 feral horses were censused. The feral horses seemed to prefer wind-blown ridges to the west of the tract; however, one herd was consistently observed on the extreme eastern sections of 84 Mesa.

2.3.5 Mammalian predators

2.3.5.1 Objectives

The purpose of the mammalian predator investigations is to fulfill the lease requirement regarding distribution and

TABLE 2-12

MULE DEER (Odocoileus hemionus) OBSERVED ON FOUR CENSUS AREAS DURING SEVEN PERIO
FOR RIO BLANCO OIL SHALE PROJECT, TRACT C-a[1/]

Date of Census	Census Area			North of Tract[2/]	Total Observed
	Tract C-a	East	West		
November 8, 1974	14	7	12	-	33
November 21	0	1	2	-	3
December 9	12	103	64	-	179
December 30	60	105	130	-	295
January 14, 1975	33	62	16	-	111
February 1	24	95	2	4	125
February 12	30	75	0	14	119
TOTALS	173	448	226	18	865

1/ The figures represent only those animals observed within the census area boundaries.

2/ Census commenced on census area north of tract on February 1, 1975.

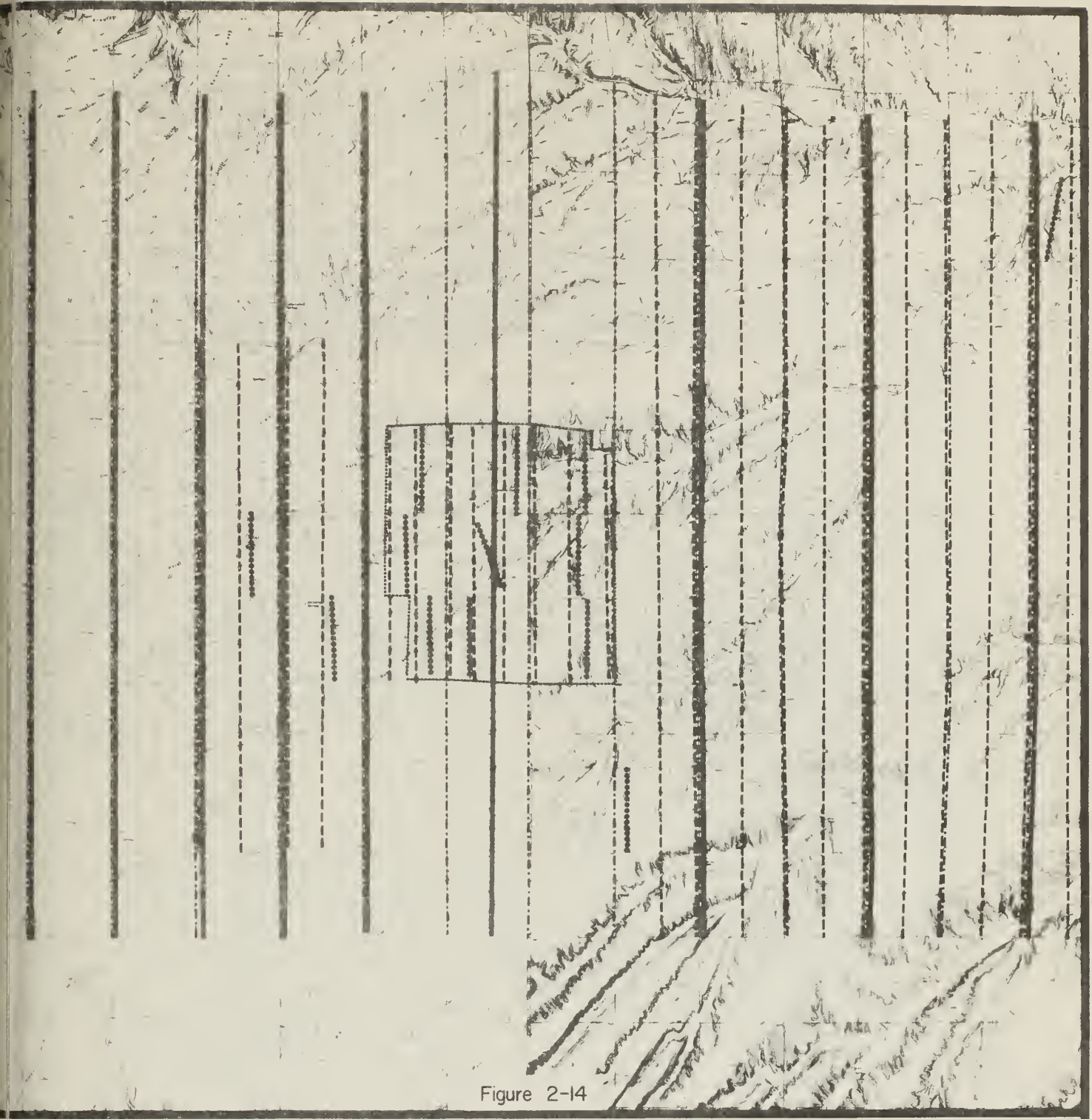

Figure 2-14

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

LARGE MAMMAL COUNTS

Aerial Transects

- deer migration route
- deer winter distribution
- elk, domestic livestock and feral horse

Ground Transects

- pellet group

N

MILES
0 1/2 1 2

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relative abundance of predators on and adjacent to Tract C-a An additional objective is to address the impact these larger predators, particularly coyotes (Canis latrans) may have on big game animals and domestic livestock in the region.

2.3.5.2 Methods

Two census methods, the scent-station visitation technique and the siren elicted howling response, were employed to gather baseline information on large predator populations. These methods were selected following a review of pertinent literature and promise to provide reliable indices of their abundance.

2.3.5.3 Results

The mammalian scent-station surveys (Figure 2-13) were conducted from November 11-15, 1974 and repeated during the week of February 10-14, 1975. Results of the siren eliciting howling response census indicate the presence of a number of coyotes in the area.

2.3.6 Winter Track Counts

Once each winter, snow-track counts are made to provide information on the distribution, relative abundance and habitat preference of herbivores and carnivores. These counts were accomplished in seven vegetation types between February 13-21, 1975. Tracks of seven animal species were encountered on the eight transects.

2.3.7 Avifauna

2.3.7.1 Objectives

The purposes of the avian census program is to identify the bird species which occur within the study area on a seasonal and annual basis, to determine their density in and use of dominant habitats as dictated in lease specifications, and to develop an objective designation of important species. The importance of avian species may be determined by demonstrating recreational value, economic impacts, rare or endangered status, esthetic value or critical role in the structure and function of the ecosystem. Habitat preferences and favored nesting habitats of breeding species are to be indicated.

2.3.7.2 Methods

Methods of censusing avifauna include bi-monthly transect counts, walk-through surveys, examination of active songbird nests, brood ground census, aerial census or raptors (Figure 2-11) ground surveys of raptors and night counts of owls.

2.3.7.3 Results

Twenty separate locations were sampled for birds during October and December 1974 and February 1975 by Emlen strip census method. Emlen strip transect locations generally correspond to the small mammal live-trap grids. A total of 37 different avian species was recorded along Emlen strip transects during the three sample periods.

Qualitative "walk-through" surveys to record additional species, including gamebirds, were conducted during the same periods as were Emlen strip censuses. Sixteen additional avian species, including two gamebirds, were recorded during the qualitative surveys.

Waterfowl surveys at Stake Springs Draw impoundment were conducted during October 1974. Only one waterfowl species, the mallard duck (Anas platyrhyncos), was observed.

Aerial raptor censuses were conducted once during November and December 1974, and twice during January and February 1975. A total of 90 individual birds representing five different raptor species was recorded during these flights.

Night owl censuses were conducted twice during December 1974 along a 35.5 km (22 mi.) road transect. Adverse road conditions did not permit sampling of the entire 48.4 km (30 mi.) transect. Four different owl species were seen or heard during the road censuses.

Fifty-seven bird species (Table 2-13) were tallied during all avian field census surveys. The golden eagle (Aquila chrysaetos) and the rough-legged hawk (Buteo lagopus) were frequently observed during the aerial surveys. The above species accounted for over 20% of all raptors enumerated. The bald eagle (Haliaetus leucocephalus) and the marsh hawk (Circus cyaneus) were observed in low numbers. Table 2-14 presents the aerial raptor survey data. Eight different raptor species were observed opportunistically during ground surveys. These included the red-tailed hawk (Buteo jamaicensis), the rough-legged hawk, the Golden eagle, marsh hawk, and the common raven (Corvus corax). All raptor species opportunistically sighted in the study area during fall and winter are listed in Table 2-14. Night transects conducted during December 1974 revealed the presence of four owl species.

2.3.8 Reptiles and Amphibians

This program determines habitat preference and, where possible, relative abundance of amphibians and reptilian species occurring on or adjacent to Tract C-a. It will begin in spring to coincide with the activity patterns of these groups.

Table 2-13 Species of birds observed during field investigations conducted in October and December, 1974, and February, 1975, for Rio Blanco Oil Shale Project, Tract C-a.

ORDER FAMILY Species	Common Name	Field Code 1/
ANSERIFORMES (Screamers, Swans, Geese & Ducks)		
ANATIDAE (Swans, Geese & Ducks)		
Anas platyrhynchos	Mallard	ANPL
FALCONIFORMES (Vultures, Hawks & Falcons)		
ACCIPITRIDAE (Hawks, Old World Vultures and Harriers)		
Buteo jamaicensis	Red-tailed hawk	BUJA
Buteo lagopus	Rough-legged hawk	BULA
Aquila chrysaetos	Golden eagle	AQCH
Haliaeetus leucocephalus	Bald eagle	HALE
Circus cyaneus	Marsh hawk	CICY
FALCONIDAE (Caracaras and Falcons)		
Falco mexicanus	Prairie falcon	FAME
Falco sparverius	American kestrel	FASP
GALLIFORMES (Megapodes, Curassows, Pheasants and Hoatzins)		
TETRAONIDAE (Grouse and Ptarmigans)		
Dendragapus obscurus	Blue grouse	DEOB
Centrocercus urophasianus	Sage grouse	CEUR
CHARADRIIFORMES (Shorebirds, Gulls, Auks, and Allies)		
CHARADRIIDAE (Plover, Turnstones and Surfbirds)		
Charadrius vociferus	Killdeer	CHVO
STRIGIFORMES (Owls)		
STRIGIDAE (Typical owls)		
Otus asio	Screech owl	OTAS
Bubo virginianus	Great horned owl	BUVI
Glaucidium gnoma	Pygmy owl	GLGN
Asio flammeus	Short-eared owl	ASFL

Table 2-13 (Continued)

ORDER FAMILY Species	Common Name	Field Code 1/
PICIFORMES (Woodpeckers, Jacamars, Toucans and Barbets)		
PICIDAE (Woodpeckers and Wrynecks)		
Colaptes auratus cafer	Common (red-shafted) flicker	COAC
Dendrocopos pubescens	Downy woodpecker	DEPU
PASSERIFORMES (Perching birds)		
ALAUDIDAE (Larks)		
Eremohpila alpestris	Horned lark	ERAL
CORVIDAE (Jays, Magpies and Crows)		
Cyanocitta stelleri	Steller's jay	CYST
Aphelocoma coerulescens	Scrub jay	APCO
Gymnorhinus cyanocephalus	Pinyon jay	GYCY
Pica pica	Black-billed magpie	PIPI
Corvus corax	Common raven	COCO
Nucifraga columbiana	Clarks' nutcracker	NUCO
PARIDAE (Titmice, Verdins and Bushtits)		
Parus atricapillus	Black-capped chickadee	PAAT
Parus gambeli	Mountain chickadee	PAGA
Parus inornatus	Plain titmouse	PAIN
Psaltriparus minimus	Common bushtit	PSMI
SITTIDAE (Nuthatches)		
Sitta carolinensis	White-breasted nuthatch	SICA
Sitta canadensis	Red-breasted nuthatch	SICN
Sitta pygmaea	Pygmy nuthatch	SIPY
CERTHIIDAE (Creepers)		
Certhia familiaris	Brown creeper	CEFA
TURDIDAE (Thrushes, Solitaires and Bluebirds)		
Turdus migratorius	American robin	TUMI
Sialia currucoides	Mountain bluebird	SICU
Myadestes townsendi	Townsend's solitaire	MYTO

Table 2-13 (Continued)

ORDER FAMILY Species	Common Name	Field Code 1/
PASSERIFORMES (Continued)		
SYLVIIDAE (Old World Warblers, Gnatcatchers and Kinglets)		
Regulus calendula	Ruby-crowned kinglet	RECA
MOTACILLIDAE (Wagtails and Pipits)		
Anthus spinoletta	Water pipit	ANSP
BOMBYCILLIDAE (Waxwings)		
Bombycilla cedrorum	Cedar waxwing	BOCE
LANIIDAE (Shrikes)		
Lanius excubitor	Northern shrike	LAEX
STURNIDAE (Starlings)		
Sturnus vulgaris	Starling	STVU
PARULIDAE (Wood warbler)		
Dendroica coronata	Yellow-rumped warbler	DECO
PLOCEIDAE (Weaver finches)		
Passer domesticus	House sparrow	PADO
ICTERIDAE (Meadowlarks, Blackbirds and Orioles)		
Sturnella neglecta	Western meadowlark	STNE
Euphagus cyanocephalus	Brewer's blackbird	EUCY
FRINGILLIDAE (Grosbeaks, Finches, Sparrows and Buntings)		
Carpodacus mexicanus	House finch	CAME
Leucosticte atrata	Black rosy finch	LEAT
Leucosticte australis	Brown-capped rosy finch	LEAU
Junco hyemalis hyemalis	Dark-eyed (slate-colored) junco	JUHY
Junco hyemalis oreganus	Dark-eyed (Oregon) junco	JUHO
Junco caniceps	Gray-headed junco	JUCA
Amphispiza belli	Sage sparrow	AMBE
Pizella arborea	Tree sparrow	SPAR

Table 2-13 (Continued)

ORDER FAMILY Species	Common Name	Field Code [1]
PASSERIFORMES (Continued)		
FRINGILLIDAE (Continued)		
Zonotrichia leucophrys	White-crowned sparrow	ZOLE
Passerella iliaca	Fox sparrow	PAIL
Melospiza melodia	Song sparrow	MEME
Rhynchophanes mccownii	McCown's longspur	RHMC
Calcarius ornatus	Chestnut-collared longspur	CAOR
Plectrophenax nivalis	Snow bunting	PLNI

[1] Four letter code, based on the first two letters of the generic and specific or subspecific, used to record species on field data sheets.

TABLE 2-14

RAPTOR SPECIES ENCOUNTERD DURING AERIAL SURVEYS, NIGHT TRANSECTS AND OPPORTUNISTIC SIGHTINGS FALL AND WINTER, 1974, AND SPRING, 1975 FOR THE RIO BLANCO OIL SHALE PROJECT

Species	Total Number Observed						
	Aerial Surveys				Ground Investigations		
	Nov.	Dec.	Jan.	Feb.	Oct.	Dec.	Feb.
Rough-legged hawk (Buteo lagopus)	2	3	7	9	0	9	6
Red-tailed hawk (Buteo jamaicensis)	0	0	0	0	6	2	0
Marsh hawk (Circus cyaneus)	1	0	0	0	6	2	0
Golden eagle (Aquila chrysaetos)	5	3	5	5	10	4	8
Bald eagle (Haliaeetus leucocephalus)	0	0	0	2	0	0	0
Prairie falcon (Falco mexicanus)	0	0	0	0	0	1	0
American kestrel (Falco sparverius)	0	0	0	0	1	0	0
Screech owl (Otus asio)	0	0	0	0	0	1[1/]	0
Great horned owl (Buba virginianus)	0	0	0	0	0	3[1/]	2
Pygmy owl (Glaucidium gnoma)	0	0	0	0	0	1[1/]	0
Short-eared owl (Asio flammeus)	0	0	0	0	0	2[1/]	0
Common raven (Corvus corax)	4	3	20	21	5	8	47
TOTALS	12	9	32	37	28	33	63

1/ Observed during night transects on December 16 and 17, 1974.

2.3.9 Invertebrates

The invertebrates sampling program is designed to survey invertebrate groups in major habitat types within the site vicinity, identify important groups based on relative abundance and biomass and address habitat requirements or preference.

Capture techniques will vary with the invertebrate type, necessitating a number of sampling procedures. The collection will commence in May 1975, with subsequent laboratory analysis.

2.3.10 Domestic Livestock

Several techniques will be utilized to estimate livestock numbers in the study area. They are aerial census, ground observations and literature searches of BLM cattle allotment records. These sightings will be located on a map for interpretations.

2.4 Aquatic Studies

The Aquatic Baseline Data Accumulation Program is intended to perform those environmental studies described in the Federal Register, Volume 39, Number 230, Part 3, Oil Shale Lease Environmental Stipulations and in the Tract C-a Exploratory Plan of May 1974. Specific lease requirements addressed were: "The Lessee shall make studies of the flora and fauna...and also of the aquatic habitat as far downstream as the Mining Supervisor shall require." "The Lessee shall compile an inventory of natural surface features, such as springs and seeps."

No detailed studies of the aquatic ecosystems of Tract C-a have been made prior to the present baseline study. However, studies of similar habitats indicate that the composition and abundance of the aquatic flora and fauna are primarily determined by the permanency of flow.

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development. The ongoing programs are summarized in Table 2-15. .

In order to fulfill these objectives, 35 sampling stations have been selected to represent the general aquatic habitats present. Emphasis has been placed on Yellow Creek and the White River. The locations of aquatic sampling stations are depicted in Figure 2-15. Sampling periods were October-November 1974 and December 1974-January 1975. The condition (dry or flowing) of each station during the first quarter and dates on which aquatic samples were taken are shown in Table 2-16. Physical, chemical, and biological parameters are taken concurrently.

2.4.1 Physical and Chemical Characteristics

2.4.1.1 Objectives

The physical and chemical characteristics of aquatic habitat on and in the vicinity of Tract C-a are studied by recording flow data and load of organic and inorganic constituents of these water.

TABLE 2-15

SUMMARY OF RIO BLANCO TRACT C-a AQUATIC SAMPLING PROGRAMS, PICEANCE CREEK BASIN, COLORADO
OCT.-NOV. 1974, DEC. 1974-JAN. 1975

Group Sampled	Objective	Methodology	No. of Sample Sites and Sample Date Oct.-Nov.'74	Dec.-Jan.'74
NUS Field Studies				
Physical measurements	To measure existing physical parameters	Flow, O_2, pH, cond., and temp. meters	27	24
Water chemistry	Analysis of certain chemical characteristics of particular biological significance	Pump-type or bottle-type	27	24
Phytoplankton	Population studies and species inventory	Pump-type or bottle-type	27	24
Zooplankton	Population studies and species inventory	Wisconsin nets w/flow meter or pump	27	24
Periphyton	To estimate abundance and determine biomass	Scraped off rock	27	24
Prim. prod.	To determine productivity of the periphyton community	Chambers	--	--

TABLE 2-15 (Continued)

Group Sampled	Objective	Methodology	No. Sample Sites and Sample Date Oct.-Nov. '74	Dec.-Jan. '74
Benthos	Population studies and species inventory	Ekman, modified Surber, D-frame	27	24
Macrophytes	Species inventory	Random transect	27	24
Fish	Population studies, species inventory, condition, food habits	Electrofishing/ seining	15	15
Sediment chemistry	To measure existing chemical characteristics of the sediment		27	24
Rare and endangered species			Opportunistic	
Springs and seepages			Opportunistic	

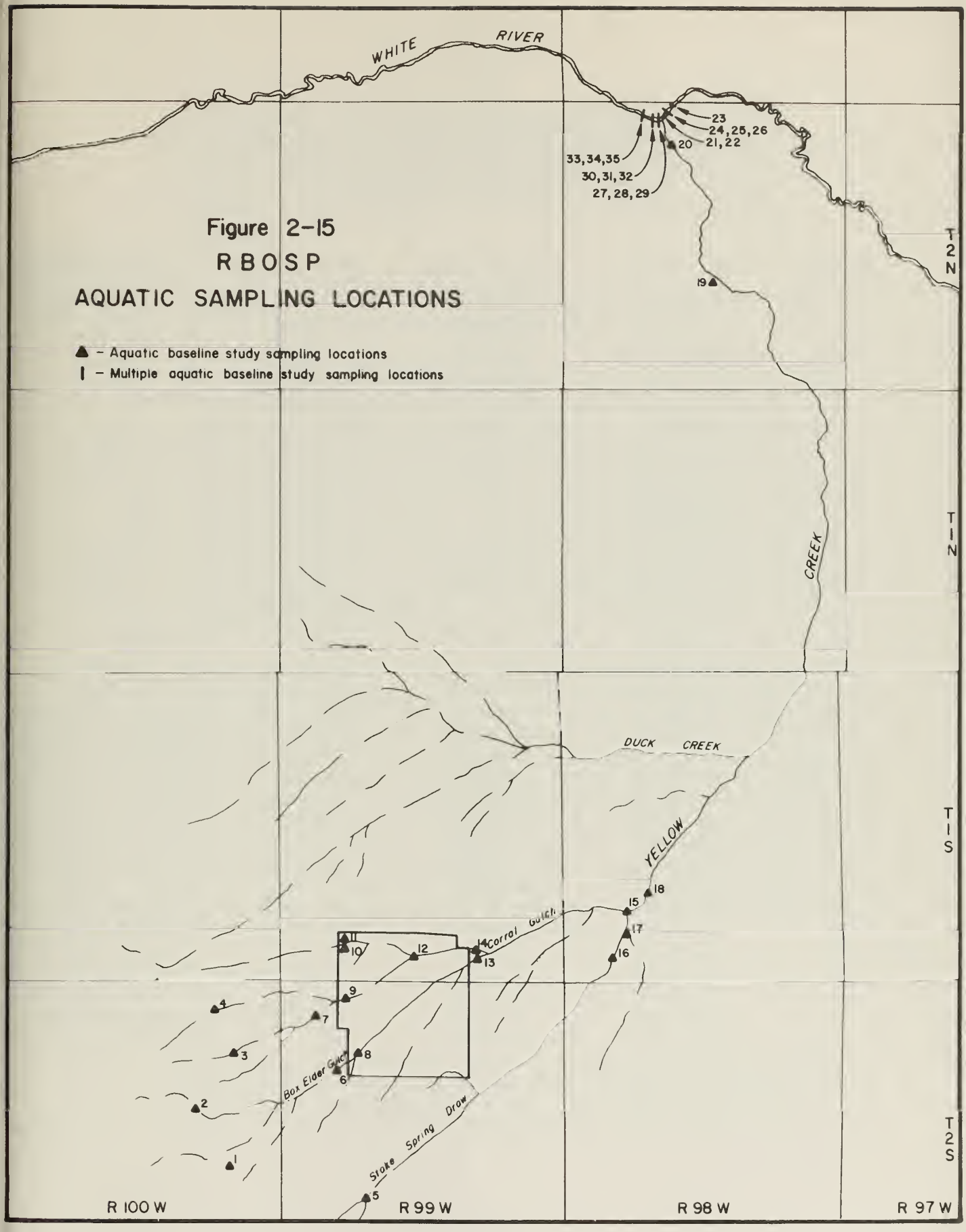


Figure 2-15
RBOSP
AQUATIC SAMPLING LOCATIONS

▲ – Aquatic baseline study sampling locations
| – Multiple aquatic baseline study sampling locations

TABLE 2-16

DATES ON WHICH AQUATIC SAMPLES WERE TAKEN AND FLOW CONDITIONS AT AQUATIC SAMPLING STATIONS DURING FIRST QUARTER OF STUDY, OCTOBER 1974 - FEBRUARY 1975 FOR RIO BLANCO OIL SHALE PROJECT

Station	Date Sampled	Flow Condition	Date Sampled	Flow Condition
1	11- 7-74	Flowing	1 -10-75	Inaccessible
2	11- 8-74	Flowing	1 -10-75	Inaccessible
3	11- 1-74	Flowing	1 -15-75	Flowing
4	10-24-74	Flowing	1 -14-75	Flowing
5	11- 5-74	Flowing	1 -16-75	Flowing
6	11- 4-74	Dry	1 -10-75	Dry
7	10-24-74	Flowing	1 -10-75	Flozen
8	11- 4-74	Flowing	1 -10-75	Flowing
9	11- 5-74	Flowing	1 -10-75	Flowing
10	10-25-74	Dry	12- 9-74	Dry
11	10-25-74	Dry	12- 9-74	Dry
12	11- 4-74	Dry	12- 9-74	Dry
13	11- 4-74	Flowing	12- 9-74	Flowing
14	11- 6-74	Flowing	1 - 6-75	Flowing
15	10-31-74	Dry	12- 9-74	Frozen
16	10-31-74	Dry	12- 9-74	Dry
17	10-31-74	Dry	12- 9-74	Dry
18	10-31-74	Dry	12- 9-74	Frozen
19	10-31-74	Flowing	1 - 6-75	Flowing
20	10-30-74	Flowing	12- 4-74	Flowing (Ice covered
21	10-30-74	Flowing	12- 4-74	Flowing (Ice covered
22	10-29-74	Flowing	12- 4-74	Flowing (Ice covered
23	11-12-74	Flowing	12-10-74	Flowing (Ice covered
24	10-17-74	Flowing	12- 5-74	Flowing (Ice & Slush
25	10-17-74	Flowing	12- 5-74	Flowing (Ice & Slush
26	10-17-74	Flowing	12- 5-74	Flowing (Ice & Slush
27	10-16-74	Flowing	12- 2-74	Flowing (Ice & Slush
28	10-16-74	Flowing	12- 2-74	Flowing (Ice & Slush
29	10-15-74	Flowing	12- 2-74	Flowing (Ice & Slush
30	10-18-74	Flowing	12- 3-74	Flowing (Ice & Slush
31	10-18-74	Flowing	12- 3-74	Flowing (Ice & Slush
32	10-18-74	Flowing	12- 3-74	Flowing (Ice & Slush
33	10-19-74	Flowing	12-10-74	Ice covered
34	10-19-74	Flowing	12-10-74	Flowing (Ice & Slush
35	10-19-74	Flowing	12-10-74	Flowing (Ice & Slush

2.4.1.2 Methods

The following physical and chemical parameters were determined: stream flow and velocity, substrate, color, odor, turbidity, dissolved oxygen, pH, salinity, temperature, depth, width and water chemistry. Standard field and laboratory procedures are followed in each case. Table 2-17 lists specific water chemistry parameters and methodologies.

2.4.1.3 Results

Flow conditions during the first quarter of sampling (October 1974-February 1975) are summarized in Table 2-16.

During October and November 1974, specific conductance ranged from 600 to 1500 micromhos/cm in the White River and was 2800 to 3000 micromhos/cm at stations in Yellow Creek; the pH range at the White River stations was 8.0 to 8.7, while in Yellow Creek it was 8.2 to 8.6. Total alkalinity varied from 178 to 224 mg/l (as $CaCO_3$) in the White River and from 722 to 1264 mg/l (as $CaCO_3$) in Yellow Creek. Concentrations of chloride ranged from 28 to 36 mg/l in the White River and from 28 to 109 mg/l in Yellow Creek; while sulfate concentrations varied from 49 to 52 mg/l in the White River and from 163 to 296 mg/l in Yellow Creek. In addition, dissolved solids concentrations ranged from 452 to 496 mg/l in the White River and from 2000 to 2100 mg/l in Yellow Creek.

During the December 1974-January 1975 sampling period, specific conductance varied from 700 to 1000 micromhos/cm in the White River and from 2500 to 3500 micromhos/cm in Yellow Creek. In the White River the pH ranged from 8.0 to 8.6 while in Yellow Creek it was 8.0 at all stations. The total alkalinity ranged from 185 to 358 mg/l (as $CaCO_3$) in the White River and from 745 to 1341 mg/l (as $CaCO_3$) in Yellow Creek; while chloride concentrations varied from 33 to 48 mg/l in the White River and from 25 to 29 mg/l in Yellow Creek. The range of sulfate concentrations in the White River was 50 to 69 mg/l, while in Yellow Creek it was 170 to 292 mg/l. Dissolved solids concentrations varied from 461 to 699 mg/l in the White River and from 2010 to 2343 mg/l in Yellow Creek.

2.4.2 Phytoplankton

2.4.2.1 Objectives

Plankton species present, their diversity and abundance, are determined. Quantitative studies allow characterization of the habitat and are a basis for comparing future changes which may occur. These studies more than fulfill lease stipulations.

TABLE 2-17

WATER CHEMISTRY PARAMETERS BEING STUDIED FOR RIO BLANCO OIL SHALE PROJECT, TRACT C-a

Measurement	Measurement* Methodology	Detection Limit (mg/l)	Sample Preservation
Alkalinity, total	Colorimetric	2.0	None required
Ammonia nitrogen	Electrode	0.10	$HgCl_2$
Calcium, soluble	Atomic absorption	0.02	None required
Chloride, dissolved	Potentiometric	0.04	None required
Hardness, total	EDTA Titration	2.0	None required
Magnesium, dissolved	Atomic absorption	0.005	HNO_3
Kjeldahl nitrogen	Kjeldahl digestion	0.70	$HgCl_2$
Nitrate, dissolved	Brucine	0.2	$HgCl_2$
Nitrate, dissolved	Diazotiaztion	0.01	$HgCl_2$
Phosphate, ortho (dissolved)**	Ammonia molybdate potassium antimonyl tartrate	0.005	$HgCl_2$
Phosphate, total**	Same as orthophosphate	0.01	$HgCl_2$
Potassium, dissolved	Atmic absorption	0.01	HNO_3
Silica, dissolved	Molybdosilicate	0.005	HNO_3
Sodium, dissolved	Atomic absorption	0.005	HNO_3
Sulfate, dissolved	Gravimetric	0.15	Refrigeration
Carbon, dissolved organic	Beckman TOC Analyzer	2.0	H_2SO_4
Carbon, total organic	Beckman TOC Analyzer	2.0	H_2SO_4
Solids, suspended	Filtration	1.0	None required
Solids, total dissolved	Filtration and evaporation	1.0	None required
	SEDIMENT CHEMISTRY		
Arsenic	Extraction & Atomic Absorption	0.005	HNO_3
Aluminum	Extraction & Atomic Absorption	0.1	HNO_3
Herbicide	Gas Chromatography	10 ppb	Refrigeration
Lead	Extraction & Atomic Absorption	0.005	HNO_3
Mercury	Extraction & Atomic Absorption	0.2	HNO_3
Nitrogen, total Kjeldahl	Kjeldahl digestion	0.7	$HgCl_2$
Phosphate, total**	Same as orthophosphate	0.01	$HgCl_2$
Solids, total volatile	Filtration, evaporation volatilization	1.0	None required
Zinc	Extraction & Atomic Absorption	0.02	Refrigeration

* All methods are according to APHA (1971) unless otherwise designated.
** EPA (1971)

2.4.2.2 Methods

Phytoplankton are collected with pump-type samplers, transferred to opaque bottles, preserved and stored in the dark. Live samples are taken in plastic bottles and refrigerated. Preserved samples are concentrated, identified and enumerated in the laboratory. Subsamples are specially treated for diatom analysis.

2.4.2.3 Results

In October-November 1974, phytoplankton abundance was quite low in samples from headwater stations above Tract C-a. At all of these stations, the dominant group of phytoplankton was the diatoms. The most abundant species include: Achnanthes minutissima, Animoneis sphaephora, Fragilaria construens, Nivicula cryptocephala, N. viridula, Nitzschia frustulum, N. linearis, Cymbella affinis, and Synedra amphicephala. On Tract, diatoms were also generally dominant, with the exception of Station 8, where Chrysidiastrum catenatum, a species of Chrysophyceae, was dominant. The most abundant species at Tract stations included: Achnanthes minutissima, Cymbella affinis, Navicula salinarum, Epithemia sorex, Synedra amphicephala; and the blue-green algae, Merismophedia glauca and M. tennuissima. At Yellow Creek stations, the most abundant organisms were the diatoms, including the following species: Achnathes minutissima, Cyclotella meneghinina, Cymbella affina, Epithemia sorex, and Synedra amphicephala. In the White River, the most abundant phytoplankton were, again diatoms. The abundant species included: Achnanthes minutissima, Epithemia sorex, Fragilaria capucina, Navicula salinarum, Cymbella affinis, Nitzschia frustulum, Diatoma vulgare, and Comphonema olivaceum. A complete species list of phytoplankton collected during the October-November and December-January samplings is presented in Table 2-18.

2.4.3 Zooplankton

2.4.3.1 Objectives

Plankton species present, their diversity and abundance, are determined to fulfill lease stipulations. Quantitative studies allow characterization of the habitat and are a basis for comparing future changes which may occur.

2.4.3.2 Methods

Zooplankton are collected with Wisconsin nets equipped with calibrated flowmeters. Two laboratory methods are used to count and identify specimens.

TABLE 2-1

LIST OF PHYTOPLANKTON SPECIES OBSERVED DURING RBOSP AQUATIC BASELINE STUDIES, OCTOBER - NOVEMBER 1974 AND DECEMBER 1974 - JANUARY 1975

	Oct. - Nov.	Dec. - Jan.
CYANOPHYTA		
Anabaena sp.	x	x
Calothrix epiphytica	x	
Calothrix sp.	x	x
Chroococcus limneticus	x	
Lyngbya sp.	x	
Merismophedia glauca	x	
M. tenuissima	x	x
Oscillatoria tenuis	x	x
Oscillatoria sp.	x	
Rivularia sp.	x	
Schizothrix calcicola	x	x
CHLOROPHYTA		
Ankistrodesmus convolutus	x	
A. falcatus	x	x
Carteria dissecta	x	
Chlamydomonas globosa	x	x
Cladophora fracta	x	
Cladophora sp.	x	x
Coclastrum microporum		x
Closterium jenneri	x	
C. leibleinii	x	
C. moniliferum	x	
C. parvulum	x	
C. venus	x	
Coelastrum microporum	x	
Cosmarium sp.		x
Crucigenia guadricauda	x	
Dictyosphaerium pulchellum	x	
Lagerheimia clilata	x	

TABLE 2-18 (Continued)

	Oct. - Nov.	Dec. - Jan.
Oedogonium sp.		x
Oocystis boregi	x	
Pandorina morum	x	
Quadrigula chodatii	x	
Scenedesmus bijuga	x	
S. quadricauda	x	
Sphaerocystis schroeteri	x	x
Spirogyra sp.	x	x
Stigeoclonium sp.		x
Ulothrix zonata		x
Ulothrix sp.		x
Unidentified chlorophyte	x	x
Zygnema sp.	x	
Unidentified falgellate	x	x
CRYPTOPHYTA		
Cryptomonas erosa		x
Rhadomonas minuta		x
EUGLENOPHYTA		
Euglena proxima	x	x
Euglena sp.	x	x
Phacus sp.	x	
Trachelomonas pulchella		x
T. volvocina	x	x
Trachelomonas sp.	x	
PYRRHOPHYTA		
Gymnodinium sp.	x	
Peridinium pusillum	x	
CYRPTOPHYTA		
Cryptomonas erosa	x	
Rhodomonas minuta	x	
Unidentified flagellate	x	

ABLE 2-18 (Continued)

CHRYSOPHYTA

	Oct. - Nov.	Dec. - Jan.
Achnanthes lanceolata	x	x
A. minutissima	x	x
Amphora ovalis	x	x
A. ovalis var. pediculus	x	
A. montana	x	
Anomoeneis sphaeophora	x	
Asterionella formosa	x	
Caloneis amphisbaena	x	x
Campylogiscus hibernicus	x	
Chrysidianstrum catenatum	x	x
Cocconeis pediculus	x	
C. placentula	x	
Cyclotella meneghinina	x	x
Cylindrotheca aciculare	x	
C. gracilis	x	
Cylindrotheca sp.	x	
Cymatopleura elliptica	x	
C. solea	x	
Cymbella affinis	x	x
C. cesati	x	
C. sinuata	x	
C. tumida	x	
C. ventricosa	x	x
Diatoma hiemale		x
D. tenue	x	x
D. tenue var. elongatum	x	
D. vulgare	x	x
Didymosphenia geminata	x	
Epithemia sorex	x	x
E. turgida	x	
Fragilaria capucina	x	
F. construens	x	x
F. crotonensis	x	x
F. leptostauron	x	x
F. pinnata	x	x
F. vaucheriae	x	x
F. virescens	x	x
Gomphonema acuminatum		x
G. angustatum	x	

TABLE 2-18 (Continued)

	Oct. - Nov.	Dec. - Jan.
G. constrictum		x
G. intricatum		x
G. lacustris		x
G. lanceolatum	x	
G. olivaceum	x	x
G. parvulum	x	
G. ventricosum	x	x
Gyrosigma accuminatum	x	x
Hannaea arcus	x	x
Hantzschia amphioxys	x	x
Melosira granulata	x	x
M. varians	x	x
Melosira sp.	x	x
Meridion circulare	x	x
Navicula arvensis		x
N. capitata	x	
N. cryptocephala	x	x
N. decussis	x	
N. exigua	x	
N. minima	x	x
N. peregrina	x	
N. pupula	x	
N. radiosa	x	x
N. rhynchocephala	x	
N. salinarum	x	x
Navicula sp.	x	x
N. tripunctata	x	x
N. viridula	x	x
Neidium iridis	x	
Nitzschia acicularis	x	x
N. apiculatae	x	x
N. capitella	x	
N. denticula	x	
N. dissipata	x	
N. frustulum	x	x
N. gracilis	x	x
N. holsatica	x	x
N. linearis	x	x
N. longissima	x	x
N. palea	x	x
N. sigma	x	x
N. sigmoidea	x	x
N. tryblionella	x	

TABLE 2-18 (Continued)

	Oct. - Nov.	Dec. - Jan.
Nitzscharia vermicularis		x
Pinnularia brebissonii	x	x
Pinnularia sp.	x	
Pleurosigma delicatulum	x	
Rhoicosphenia curvata	x	x
Rhopalodia gibba	x	x
R. gibberula	x	
Stephanodiscus astraea	x	
S. niagarae	x	
S. tenuis	x	x
Surirella angustata	x	
S. ovalis	x	x
S. ovata	x	x
Surirella sp.	x	
Synedra amphicephala	x	x
S. pulchella	x	x
S. ulna	x	x

2.4.3.3 Results

During the October-November 1974 sampling period, the dominant zooplankton species in stations located in the headwater areas were the Protozoa: Centropyxis aculeata, C. arcelloides, C. constricta and Vorticells sp. : Bdelloid rotifers; and Bryocamptus heimalis and crustacean nauplii. At Tract stations, the most abundant species were the Protozoa: Cehtropyxis aculeata, C. constricta; the Rotifera: Cephalodella gibba, Cephalodella sp., Notholca acuminata and N. squamula; and ostracods and crustacean nauplii. In stations on Yellow Creek, the most abundant species were: Centropyxis aculeata, Notholca acuminata, and crustacean nauplii. At White River stations, Centropyxis aculeata, Vorticella sp., Lepadella sp. and Monostyla sp. were the most abundant species. During the October-November 1974 sampling, a total of 41 zooplankton taxa was collected (Table 2-19).

Partial analysis of zooplankton samples collected during December 1975-January 1975 indicates the following. The most abundant species at headwater stations included species of Centropyxis, Bdelloid rotifers, and crustacean nauplii. At Tract stations, the most abundant species were species of Centropxys, species of Notholca and ostracods. In stations on Yellow Creek, the most abundant zooplankton species are those belonging to the genus Centropyxis and the species Monstyla sp. In the White River, the most abundant species observed included species of Centropyxis, Vorticella sp. and Proales sp.

2.4.4 Periphyton

2.4.4.1 Objectives

The abundance and species composition of periphyton will be determined as required in the lease.

2.4.4.2 Methods

These objectives will be met by qualitative and quantitative substrate sampling. Six replicates are collected from each site. Samples (from a 50 cm^2 area) are collected from rocks and preserved. Laboratory analysis involves concentration, staining, identification and enumeration. Biomass determinations are obtained from dry-weight measurements.

TABLE 2-1[illegible]

LIST OF ZOOPLANKTON SPECIES OBSERVED DURING RBOSP AQUATIC BASELINE STUDIES, OCTOBER - NOVEMBER 1974 AND DECEMBER 1974 - JANUARY 1975

	Oct. - Nov.	Dec. - Jan.
PROTOZOA		
Actinophrys sp.	x	
Centropyxis aculeata	x	x
C. arcelloides	x	
C. constricta	x	x
Chilodonella cucullula		x
Ciliate (Unidentified)		x
Codonella cratera	x	
Cyphoderia ampulla	x	x
Didinium nasutum		x
Didinium sp.	x	
Difflugia acuminata	x	x
Difflugia sp.	x	
Dinamoeba mirabilis	x	
Epistylis sp.	x	x
Euglypha laevis	x	
Paramecium sp.	x	x
Platyophrya sp.		x
Strobilidium sp.	x	x
Vorticella sp.	x	x
ROTIFERA		
Bdelloidea	x	x
Brachionus guadridentata	x	
Cephalodella gibba	x	x
C. forficula		x
Cephalodella sp.		x
Colurella spp.	x	x
Filinia sp.	x	
Keratella cochlearis	x	
K. guadrata	x	
Lecane sp.	x	x
Lepadella sp.	x	x
Monostyla bulla	x	x
M. closterocerca		x
M. lunaris		x
Monostyla sp.	x	x

TABLE 2-19 (Continued)

	Oct. - Nov.	Dec. - Jan.
Notholca acuminata	x	x
N. squamula	x	x
Proales sp.		x
Rotifer (contracted) spp.	x	x
ARTHROPODA		
Hydracarina	x	
Crustacea		
Alona guttata		x
A. rectangula	x	
Bryocamptus hiemalis	x	x
Ceriodaphnia guadrangula	x	x
Chydorus sphaericus	x	x
Cyclopoid copepodites	x	x
Cyclops vernalis	x	x
Eucyclops agilis	x	x
Nauplii	x	x
Ostracoda	x	x
Pleuroxus aduncus	x	x
Simocephalus vetulus	x	x

2.4.4.3 Results

In the October-November 1974 samples, periphyton abundance was generally less at headwater stations than elsewhere. Diatoms were the dominant periphytic group at these stations, with Achnanthes minutissima, Nitzschia baccata, N. frustulum, Synedra amphicephala, Cocconeis placentula, Cyclotella meneghinia, Fragilaria vaucheriae, Gomphonema intricatum, Navicula crytocephala and Pleurosigma delicatulum as the most abundant species. In addition, the blue-green algae Lyngbya sp. and Plectonema sp. were abundant at Stations 1 and 2. The dominant diatoms on tract were Achnanthes minutissima, A. lanceolata, Navicula cryptocephala, Gomphonema intricatum, Niizschia linearis and N. denticula. The blue-green algae species Lyngbya sp. and Plectonema sp. were also abundant at Station 13. Yellow Creek stations were dominated by diatoms, with Achnanthes minutissima, Cymbella affinis, Nitzchia frustulum and Rhopalodia gibba as the most abundant species. The blue-green algae Rivularia sp. was also quite abundant at Station 20. In the White River, the diatoms were the most abundant periphytic group and the most abundant species included: Epithemia sorex, Navicula cryptocephala, N. salinarum, Nitzschia frustulum, N. dissipata, Synedra ulna, Gomphonema olivaceum and Cymbella affinis. In addition, the blue-green species Rivularia sp., Lyngbya sp., and Oscillatoria sp. were abundant at many of the White River stations.

A list of the periphyton species collected during the October-November and December-January samplings is presented in Table 2-20.

2.4.5 Benthos

2.4.5.1 Objectives

Data for calculating species diversity indices of benthos will be collected. Classically, benthos may be expected to be the main source of energy transfer from periphyton and detritus to fish. Determination of such ecological relationships is specifically mentioned in the lease.

2.4.5.2 Methods

Benthos was primarily collected with a modified Surber sampler with minimal use of a D-frame. Samples are washed, preserved and transported to the laboratory for analysis. Specimens were identified to lowest possible taxon.

TABLE 2-20

LIST OF PERIPHYTON SPECIES OBSERVED DURING RBOSP AQUATIC BASELINE STUDIES OCTOBER-NOVEMBER 1974 and DECEMBER 1974-JANUARY 1975

	Oct.-Nov.	Dec.-Jan.
CYANOPHYTA		
Anabaena sp.	x	
Calothrix sp.	x	x
Lyngbya sp.	x	x
Oscillatoria sp.	x	x
Plectonema sp.	x	x
Rivularia sp.	x	x
Schizothrix sp.	x	
CHLOROPHYTA		
Cladophora sp.	x	x
Dictyosphaerium germinata	x	
Spirogyra sp.		x
Ulothrix sp.	x	
Zygnema sp.	x	x
CRYPTOPHYTA		
Cryptomonas erosa	x	
CHRYSOPHYTA		
Achnanthes hauckiana	x	
A. lanceolata	x	x
A. minutissima	x	x
Amphipleura pellucida	x	x
Amphiprora ornata	x	x
Amphora sp.	x	
A. ornata	x	x
A. ovalis	x	x
A. ovalis var. pediculus	x	x
A. perpusilla		x

TABLE 2-20 (Continued)

	Oct. - Nov.	Dec. - Jan.
	x	x
Caloneis amphisbanea	x	x
C. bacillum	x	x
C. ventricosa	x	x
Cocconeis pediculus	x	x
C. placentula	x	x
Cyclotella meneghiniana	x	x
Cymatopleura solea	x	x
Cymbella affinis	x	
C. delicatula	x	
C. cistula	x	x
C. microcephala	x	x
C. prostrata	x	
C. pusilla	x	x
C. sinuata	x	
C. turgida	x	x
C. ventricosa		
Diatoma hiermale		x
D. tenue var. elongatum	x	x
D. vulgare	x	x
Didymosphenia geminata	x	x
Epithemia sorex	x	x
E. zebra	x	
Fragilaria capucina	x	
F. construens	x	x
F. crotonensis	x	x
F. leptostauron	x	x
F. pinnata	x	x
F. vaucheriae	x	
Gomphonema angustatum	x	
G. gracile	x	
G. intricatum	x	x
G. lanceolatu	x	
G. longiceps	x	
G. olivaceum	x	x
G. parvulum	x	
G. ventricosum	x	x

TABLE 2-20 (Continued)

	Oct. - Nov.	Dec. - Jan.
Gyrosigma acuminatum	x	
Hantzschia amphioxys	x	
Hannea arcus		x
Mastogloia elliptica	x	
Melosira varians	x	
Meridion circulare	x	
Navicula arvensis	x	x
N. capitata	x	
N. cryptocephala	x	x
N. cuspidata	x	
N. minima	x	x
N. mutica	x	x
N. pelliculosa	x	x
N. pupula	x	
N. pygmaea	x	
N. rhyncocephala	x	
N. salinarum	x	x
N. salinarum var. intermedia	x	
N. seminulum	x	
N. tripunctata	x	x
N. viridula	x	x
Navicula sp. 1	x	x
Navicula sp. 2	x	x
Nitzschia acicularis	x	x
N. amphibia	x	
N. apiculata	x	x
N. bacata	x	x
N. chasei	x	x
N. denticula	x	x
N. dissipata	x	x
N. frustulum	x	x
N. gracilis	x	
N. holsatica	x	
N. hungarica	x	
N. linearis	x	x
N. longissima var. closterium	x	
N. micans	x	
N. palea	x	x

TABLE 2--20 (Continued)

	Oct. - Nov.	Dec. - Jan.
N. sigmoidea	x	x
N. tripunctata	x	
N. tryblionella	x	
N. vermicularis	x	x
Pinnularia sp. 1	x	
Pinnularia borealis	x	
P. brebissonii	x	
Pleurosigma delicatulum	x	x
P. salinarum	x	
Rhiocosphenia curvata	x	x
Rhopalodia gibba	x	x
R. gibberula	x	x
Stephanodiscus tenuis		x
Surirella angustata	x	
S. ovalis	x	
S. ovata	x	x
Surirella sp. 1	x	
Synedra amphicephala	x	x
S. pulchella	x	
S. pulchella var. lanceolata	x	
S. rumpens	x	
S. tenera		x
S. ulna	x	x
PYRROPHYTA		
Gymnodinium sp.	x	

2.4.5.3 Results

In the October-November 1974 benthos samples, large numbers of insects were in their earliest instars and, thus, many of those specimens could only be identified to family level (since the mature stage of the larvae is necessary for generic or specific identification). At the headwater stations, a total of 69 taxa was observed; the most abundant of these were the Chironomidae, Simulidae, Tipulidae, Ephemeroptera and Plecoptera. At the Tract stations, 71 taxa were found. The most abundant of these were Chironomidae, Simulidae, Oligochaeta, Ephemeroptera and Plecoptera. At the Yellow Creek stations 65 taxa were found; the most abundant species belonged to the Oligochaeta, Chironomidae and Ephemeroptera. At the White River stations, the most abundant species belonged to the Ephemeroptera. Trichoptera and Oligochaeta. A total of 93 taxa was found in the White River during this sampling period. Macroinvertebrate taxa found during the October-November sampling are listed in Table 2-21.

Analysis of December 1974-January 1975 macroinvertebrate samples completed to date presents the following picture of the benthos community during that period. The most abundant taxa belonged to the Ephemeroptera, Chironomidae, Simulidae and Oligochaeta. At Tract stations, 23 taxa were observed; the most abundant taxa included the Chironomidae, Simulidae, Ephemeroptera and Oligochaeta. In Yellow Creek, 14 taxa were observed and the most abundant taxa were Chironomidae, Simulidae and Oligochaeta. In the White River, the most abundant taxa belonged to the Ephemeroptera, Chironomidae and Trichoptera; a total of 45 taxa has been observed in White River samples to date. As indicated in Table 2-21 a total of 63 macroinvertebrate taxa, exclusive of Oligochaeta and Chironomidae, has been identified in the December 1974-January 1975 samples to date.

2.4.6 Sediment analysis

2.4.6.1 Objectives

Sediment analyses are conducted to determine chemical constituents present and relative level of herbicides found therein.

2.4.6.2 Methods

Sediment samples are collected by Eckman dredge, core sampler or by scooping. Samples are refrigerated and transported to the laboratory for analyses. Parameters analyzed are Al, As, Pb, Hg, Kjeldahl N, Total P, volatile solids and Zn.

TABLE 2-[illegible]

MACROINVERTEBRATE TAXA COLLECTED RBOSP AQUATIC BASELINE STUDY, OCTOBER - NOVEMBER 1974 and DECEMBER 1974-JANUARY 1975

	Oct.-Nov.	Dec.-Jan.
Cnidaria		
Hydrozoa		
Hydridae		
Hydra	x	
Platyhelmenthes		
Tubellaria		
Tricladida	x	
[illegible]matoda	x	
Mollusca		
Gastropoda		
Basommatophora		
Physidae		
Physa Draparnaud	x	x
Limnaeidae		
Limnaea Lamarck		x
Annelida		
Hirudinea		
Rhyncobdellida		
Glossiphoniidae		
Helobdella stagnalis (Linnaeus)	x	x
Oligochaeta		
Enchytraeidae	x	Not Completed
Naididae		
Chaetogaster diastrophus	x	
C. spp.	x	
Nais spp.	x	
N. elinguis	x	
N. cf. behningi	x	
Pristina sp.	x	

TABLE 2-21 (Continued)

Tubificidae	x	
Ilyodrilus templetoni	x	Not Completed
Limnodrilus claparedeianus	x	
L. hoffmeisteri	x	
L. udekemianus	x	
Tubifix sp.	x	
Immature tubificids w/o capilliform chaetae	x	
Immature tubificids w capilliform chaetae	x	
Rhyacrodrilinae	x	
Arthropoda		
Arachnoidea		
Acari	x	x
Crustacea		
Amphipoda		
Talitridae		
Hyallela azteca (Saussure)	x	x
Insecta		
Collembola	x	
Ephemeroptera		
Siphlonuridae		
Ameletus Eaton		x
Heptageniidae		
Epeorus Eaton	x	
Heptagenia Walsh	x	x
H. solitaria McDunnough		x
Rhithrogenia Eaton	x	x
Baetidae		
Baetis Leach	x	x
Callibaetis Eaton	x	x
Leptophlebiidae		
Choroterpes Eaton	x	
Paraleptophlebia Lestage	x	
Traverella albertana (McDunnough)	x	
Ephemerellidae		
Ephemerella Walsh	x	x
Tricorythidae		
Tricorythodes Ulmer	x	x
Caenidae		
Caenis Stephens	x	

TABLE 2-21 (Continued)

Sigara cf. lineata (Forster)		x
Trichocorixa Kirkaldy		x
T. cf. kanza Sailer		x
Gerridae		
Gerris Fabricius	x	
Notonectidae		
Notonecta Linnaeus		x
Coleoptera		
Haliplidae		
Haliplus Latrielle		x
Dytiscidae		
Agabus Leach		x
Deronectes Sharp	x	
D. coloradensis (Fall)	x	x
D. marginicollis LeConte		x
Hydrovatus Motschwsky		x
Oreodytes Seidlitz	x	
Rhantus Dejean		x
R. cf. mexicanus (Laporte)		x
Elmidae		
Dubiraphia Sanderson	x	x
D. giulianii VanDyke	x	
Microcylloepus Hinton	x	x
M. pusillus (LeConte)	x	
Optioservus Sanderson	x	
Zaitzevia Champion	x	x
Z. parvula (Horn)	x	
Trichoptera		
Glossosomatidae		
Agapetus Curtis		x
Hydropsychidae		
Cheumatopsyche Wallengren	x	x
Hydropsyche Pictet	x	x
Hydroptilidae		
Hydroptila Dalman	x	x
Neotrichia Morton	x	x
Limnephilidae		
Grammotaulius Kolenati		x

TABLE 2-21 (Continued)

Hesperophylax Banks	x	x
Leptoceridae		
Oecetis McLachlan	x	x
Lepidoptera		
Pyralidae	x	x
Diptera		
Tipulidae		
Dicranota Zetterstedt	x	x
Eriocera Macquart	x	x
Hexatoma Latreille	x	
Holorusia Loew	x	x
Limonia Meigen		x
Limnophila Macquart	x	
Ormosia Rondani	x	
Ptychopteridae		
Bittacomorphella Alexander		x
Psychodidae		
Pericoma Walker		x
Dixidae		
Dixa Meigen		x
Thaumaleidae	x	
Ceratopogonidae		x
Chironomidae		
Tanypodinae		
Ablabesmyia	x	
Conchapelopia	x	
Procladius s.s.	x	
Psectrotanypus (Macropeliopia)	x	
Diamesinae		
Diamesa	x	
Monodiamesa	x	
Odonotmesa	x	
Prodiamesa near olivacea	x	
Prodiamesa sp. 1	x	
Orthocladiinae		
Orthocladiinae sp. 1	x	
Orthocladiinae sp. 2	x	
Orthocladiinae sp. 3	x	
Cardiocladius	x	
Chaetocladius sp. 1	x	
Chaetocladius sp. 2	x	

Chironomids Not Completed

TABLE 2-21 (Continued)

Cricotopus bicinctus	x	
Cricotopus cf. trifacia	x	
Cricotopus spp.	x	
Corynoneura	x	
Eukiefferiella	x	
Orthocladius spp.	x	
Parakiefferiella	x	
Pseudosmittia	x	
Thienemanniella	x	
Chironominae		
Chironomini		
Chironomus	x	
Cryptochironomus	x	
Dicrotendipes	x	
Microtendipes	x	
Paracladopelma	x	
Paratendipes	x	
Phaenopsectra (Phaenopsectra)	x	
P. (Tribelos)	x	
Polypedilum s.s. fallax group	x	
P. "Tripodura" group	x	
Pseudochironomus	x	
Stictochironomus	x	
Tanytarsini		
Cladotanytarsus	x	
Micropsectra	x	
Paratanytarsus	x	
Rheotanytarsus	x	
Tanytarsus	x	
Simulidae		
Simulium Latreille	x	x
S. arcticum Malloch	x	
S. argus Williston	x	x
S. canadense Hearle	x	
S. cf. griseum Coquillett		x
S. vittatum Zetterstedt	x	
Stratiomyiidae		
Euparyphus Gerstaecker	x	
Tabanidae		
Chrysops Miegen	x	x
Tabanus Linneaus	x	
Rhagionidae		
Atherix variegata Walker	x	x

Chironomids Not Completed

TABLE 2-21 (Continued)

Odonata		
Zygoptera		
Coenagrionidae		
Amphiagrion abbreviatum (Selys)	x	x
Argia Rambur	x	
Enallagma Charpentier	x	
Ischnura Charpentier		x
Anisoptera		
Gomphidae		
Ophiogomphus severus Hagen	x	x
Aeshnidae		
Aeshna interrupta Walker		x
Libellulidae		
Sympetrum corruptum (Hagen)		x
Plecoptera		
Eulhognatha		
Capniidae		
Capnia Pictet	x	x
C. logana Nebeker & Gauffin		x
Taeniopterygidae		
Brachyptera Newport		x
Systellognatha		
Perlodidae		
Isogenoides Klapalek	x	x
Isoperla Banks	x	x
Chloroperlidae		
Alloperla Banks		x
Perlidae		
Claassenia sabulosa (Banks)	x	x
Hemiptera		
Corixidae		
Cenocorixa cf. bifida bifida (Hungerford)	x	x
Hesperocorixa laevigata (Uhler)		x

TABLE 2-21 (Continued)

Empididae		
Clinocera Meigen		x
Hemerodromia Meigen		x
Weidemannia Zetterstedt		x
Ephydridae		
Ephydra		x
Hemerodromia Meigen	x	
Dolichpodidae		
Hydrophorus Fallen	x	
Syrphidae		
Chrysogaster Meigen	x	
Anthomyiidae		
Limnophora aequifrons Stein	x	x
L. discreta Stein	x	x

2.4.6.3 Results

The results of chemical analyses of sediment samples are given in Tables 2-22 and 2-23. Table 2-24 contains the results of selected herbicide analysis.

2.4.7 Macrophytes

2.4.7.1 Objectives

Distribution and abundance of aquatic macrophytes is determined as a part of lease stipulations covering flora.

2.4.7.2 Methods

Macrophytes were sampled every two months using a random transect line. All plants within 0.5 m on either side of the transect are collected and identified. Voucher specimens are prepared and maintained.

2.4.7.3 Results

Aquatic macrophytes constitute an important part of the environment of streams in Colorado. These plants may provide food and cover for numerous mammals, birds, fish, reptiles, amphibians and invertebrates. Often they are also important in soil stabilization and as a source of oxygen for aquatic life.

Aquatic macrophytes were present in a few of the aquatic sampling locations during the October-November 1974 and December 1974-January 1975 sampling periods.

During October-November, horned pond weed (Zannichellia palustris L.) was found growing at a depth of 2 feet along the shore of a pond at Station 14. At Station 5, specimens of mares-tail (Hippuris vulgaria L.) were found growing in 2 feet of water near the edge of a pond; in the narrow, shallow, fast-flowing stream below the pond watercress (Rorippa nasturtium-aquaticum) was also found. At Station 19, stonewart (Chara kieneri) was quite abundant in the pond area.

2.4.8 Fish

2.4.8.1 Objectives

Fish studies are designed to determine species composition, relative importance, identification of indicator species, fish production, rare and endangered species and species of special importance to man. These goals are intended to satisfy the stipulations set forth in the lease.

TABLE 2-22

RESULTS OF SEDIMENT CHEMISTRY ANALYSIS

RBOSP Aquatic Baseline Study
October-November 1974

STATION REPLICATE	PARAMETER (mg/l)							
	Al	As	Pb	Hg (µg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
1 A	22.3	0.01	0.05	<0.2	2.30	0.95	98.3	0.10
2 A	23.5	0.02	0.06	<0.2	1.60	0.84	85.4	0.09
3 A	17.3	0.01	0.04	0.3	1.20	1.10	110.0	0.06
4 A	16.3	<0.01	0.04	<0.2	1.00	0.94	58.9	0.06
5 A	23.4	<0.01	0.03	<0.2	0.89	0.90	56.7	0.09
7 A	17.2	<0.01	0.04	0.2	1.10	0.71	46.9	0.07
8 A	22.1	0.01	0.04	0.3	0.83	0.96	75.0	0.06
9 A	19.1	0.01	0.03	<0.2	0.73	0.88	45.3	0.06
13 A	21.1	0.01	0.05	0.2	0.75	0.86	65.4	0.09
14 A	27.3	<0.01	0.04	<0.2	1.20	0.92	88.3	0.10
19 A	21.4	<0.01	0.08	<0.2	1.10	0.91	69.6	0.09
20 A	24.3	<0.01	0.05	0.4	0.76	0.61	64.1	0.07
21 A	20.6	<0.01	0.03	0.2	1.00	0.75	42.2	0.07
22 A	21.1	<0.01	0.04	0.3	1.60	0.58	72.0	0.06
23 A	17.7	<0.01	0.04	<0.2	0.89	0.54	38.5	0.07
24 A	13.4	0.01	0.01	0.3	0.39	0.85	23.9	0.06
24 B	13.0	0.01	0.01	0.3	0.76	0.75	53.8	0.06

TABLE 2-22 (Continued)

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (µg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
25 A	20.7	0.01	0.51	3.5	0.78	1.10	57.1	0.36
25 B	17.7	0.03	1.00	8.8	1.30	0.95	58.4	0.80
26 A	15.7	<0.01	0.01	0.6	0.67	0.65	43.3	0.10
26 B	19.5	0.01	0.01	0.2	0.42	0.55	33.6	0.08
27 A	11.5	<0.01	0.06	0.4	0.24	0.63	40.2	0.10
27 B	14.7	<0.01	0.03	<0.2	0.29	0.88	34.3	0.07
28 A	16.3	<0.01	0.01	<0.2	0.67	0.85	40.0	0.07
28 B	16.0	<0.01	0.01	<0.2	0.53	0.78	44.0	0.09
29 A	17.2	0.01	0.01	0.2	0.73	0.78	55.2	0.10
29 B	18.3	<0.01	0.01	2.3	0.34	0.85	60.6	0.09
30 A	15.9	<0.01	0.01	<0.2	0.81	0.85	37.7	0.07
30 B	17.6	0.01	0.01	<0.2	0.95	0.80	42.5	0.08
31 A	3.4	<0.01	0.01	<0.2	1.90	0.93	71.0	0.04
31 B	10.3	<0.01	0.01	<0.2	2.70	0.97	78.2	0.06
32 A	16.5	0.01	0.01	<0.2	0.90	0.73	34.7	0.09
32 B	17.1	<0.01	0.01	<0.2	1.10	0.68	49.1	0.08

TABLE 2-22 (Continued)

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (µg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
33 A	15.5	<0.01	0.01	<0.2	2.50	0.85	51.9	0.08
33 B	16.4	<0.01	0.01	<0.2	1.20	0.84	59.8	0.07
34 A	17.4	<0.01	0.03	0.4	1.10	0.72	46.8	0.10
34 B	21.4	<0.01	0.05	0.3	1.50	0.79	57.1	0.12
35 A	20.5	<0.01	0.01	0.3	0.89	0.66	39.3	0.08
35 B	20.2	0.01	0.01	<0.2	0.78	0.65	53.6	0.09

[1]Stations 6,10,11,12,15,16,17, and 18 were dry

TABLE 2-23

RESULTS OF SEDIMENT CHEMISTRY ANALYSIS
RBOSP Aquatic Baseline Study
December 1974-January 1975

STATION REPLICATE	PARAMETER (mg/g)							
	Al	As	Pb	Hg	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
3 A	3200	53	31	887	7600	818	147000	379
4 A	9200	37	28	203	1890	798	67600	47
5 A	12200	26	16	104	1920	657	70500	51
8 A	11200	26	26	27	824	622	44800	54
9 A	7700	35	56	263	1810	630	51600	42
13 A	13800	36	35	392	1490	450	57300	86
14 A	19600	30	33	268	1640	763	69800	66
19 A	12500	11	23	389	1690	602	73400	52
22 A	6800	13	14	1240	329	497	21600	28
23 A	4100	2	11	121	170	414	9300	21
28 A	10000	20	22	500	966	558	42800	44
34 A	4500	6	14	488	677	445	17700	28

[1]Stations 1,2,6,7,10-12,15-18,20,21,24-27,29-33, and 35 were either inaccessible, dry or frozen solid so that no samples could be obtained.

TABLE 2-24

RESULTS OF HERBICIDE ANALYSIS
FOR RBOSP AQUATIC BASELINE STUDIES

October - November, 1974

Station	Parameter	
	Tordon 22K	Silvex
1-A	< 1	< 0.1
2-A	< 1	< 0.1
3-A	< 1	< 0.1
4-A	< 1	< 0.1
5-A	< 1	< 0.1
7-A	1	< 0.1
8-A	< 1	< 0.1
9-A	< 1	< 0.1
13-A	< 1	< 0.1
14-A	< 1	< 0.1
19-A	1	< 0.1
20-A	1	< 0.1
21-A	1	< 0.1
22-A	< 1	< 0.1
23-A	< 1	< 0.1
24-A	2	< 0.1
24-B	2	< 0.1
25-A	< 1	< 0.1
26-A	< 1	< 0.1
26-B	1	< 0.1
27-A	< 1	< 0.1
27-B	< 1	< 0.1
28-A	2	< 0.1
28-B	2	< 0.1
29-A	< 1	< 0.1
30-A	< 1	< 0.1
30-B	1	< 0.1
31-A	< 1	< 0.1
31-B	< 1	< 0.1
32-A	2	< 0.1
32-B	2	< 0.1
33-A	< 1	< 0.1
33-B	< 1	< 0.1
34-A	< 1	< 0.1
34-B	< 1	< 0.1
35-A	1	< 0.1
35-B	1	< 0.1
	December, 1974 January, 1975	
3-A	1.8	
4-A	0.4	
5-A	0.5	

TABLE 2-24 (Continued)

December, 1974 January, 1975

Station	Parameter	
	Tordon 22K	Silvex
8-A	0.6	
9-A	0.6	
13-A	0.3	
14-A	0.5	
19-A	0.4	
22-A	0.4	
23-A	0.4	
28-A	0.4	
34-A	0.4	

2.4.8.2 Methods

Electrofishing was the primary collection method. This was used in conjunction with dip-netting to provide information on species presence and relative abundance. Replicates are included as a part of the sampling program.

2.4.8.3 Results

During the October-November 1974 sampling, 542 fish representing nine species were captured in the White River and lower Yellow Creek (Table 2-25). About 60 percent of these specimens were returned to the streams with the remainder being retained for further analysis. The flannelmouth and bluehead sucker, speckled dace, fathead minnow and mottled sculpin were taken most frequently. Rough and forage fishes were predominant. The catches in the White River and Yellow Creek were smaller in size. Fish data from the October-November 1974 sampling are presented in Table 2-25.

2.4.9 Springs and seeps

2.4.9.1 Objectives

Springs and seepages are studied to determine occurrence and location as required by lease stipulation.

2.4.9.2 Methods

Methods employed to determine locations of springs and seeps involved analysis of color infrared photography and field investigations.

2.4.9.3 Results

Locations of springs and seeps on or near Tract C-a are shown on Figure 2-16.

2.5 Other Environmental Programs

Baseline programs outside the scope of previously discussed studies include soils surveys, archaeological studies, re-vegetation, toxicology and trace metal studies.

2.5.1 Soils Survey and Productivity Assessment Studies

2.5.1.1 Objectives

The soils surveys are designed to fulfill the requirements of the oil shale lease, provide data necessary in the determination of ecosystem relationships and to provide information required during revegetation studies.

TABLE 2-25

LIST OF FISH SPECIES AND NUMBERS
CAPTURED IN THE WHITE RIVER AND LOWER YELLOW
CREEK RBOSP AQUATIC BASELINE STUDIES
OCTOBER-NOVEMBER 1974

Common Name	Scientific Name	Number Captured
Rainbow trout	*Salmo gairdneri*	1
Brown trout	*Salmo trutta*	1
Mountain whitefish	*Prosopium williamsoni*	7
Fathead minnow	*Pimephales promelas*	90
Longnose dace	*Rhinichthys cataractae*	4
Speckled dace	*Rhinichthys osculus*	122
Bluehead sucker	*Catostomus discobolus*	26
Flannelmouth sucker	*Catostomus latipinnis*	58
Mottled sculpin	*Cottus bairdi*	233
	TOTAL	542

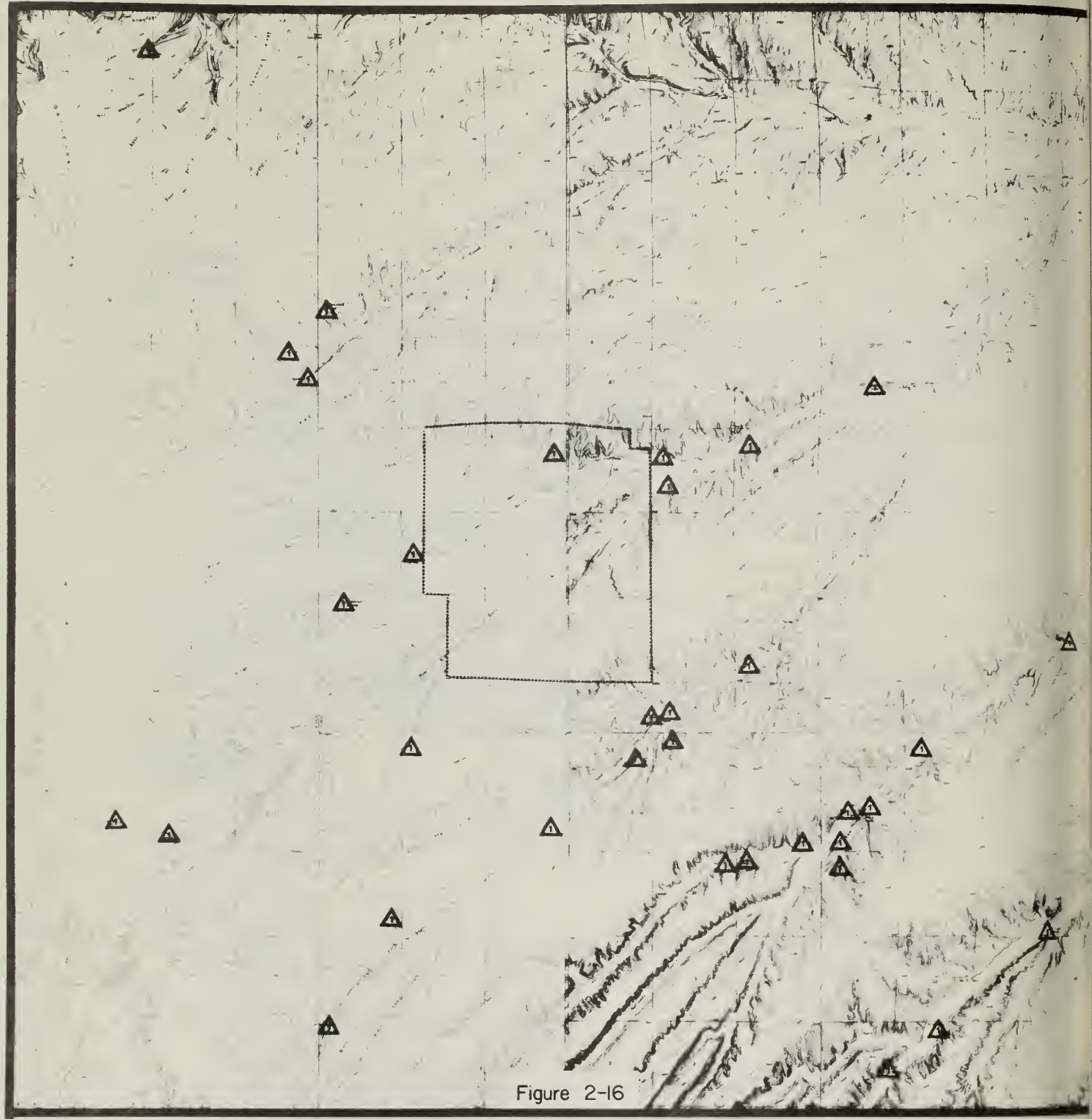


Figure 2-16

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

SPRING & SEEPAGE LOCATIONS

△ springs and seepages as of 3/75

LIMNETICS, INC.
Denver, Colorado

MILES
0 1/2 1 2

3/75

The objective of the soil survey will be to describe and map soil types. Soil types, depths of the various layers of soil, strike and dip of the soil, slopes, vegetation cover and erodibility will be described. Intensity of solar radiation, vital to revegetation success, will be obtained by the meterological and air quality contractor. Vegetative cover maps will be developed by the terrestrial contractor. Erosion potential by wind and water will be determined by the soils contractor during the collection of field samples. Each area will be defined as listed in Soil Survey Manual No. 18.

The area to be surveyed will include the leased area within one mile outside its borders as well as areas identified as spent shale disposal site and operational plant site.

2.5.1.2 Methods

The field collection program will include: soils survey and mapping, studies of nutritive sources in soils and characterization of specific chemical and physical properties of ecological importance. Soils survey and mapping will be conducted in accordance with the Soils Survey Manual and its supplement as issued by the U. S. Department of Agriculture. A reconnaissance soil map which identifies observable features relevant to the nature and behavior of the soil will be prepared. Taxonomic units or natural bodies with distinct sets of soil characteristics will be identified.

Soil samples will be collected in every major soil type to measure potential nutritive sources present as well as possible toxic elements.

Samples will be collected to characterize the soils at each vegetation sampling site, in terms of physical and chemical properties which have ecological significance, and to identify land stabilization problems in terms of identifiable soil characteristics. Plant-soil relationships occuring in the various ecosystems within the study area will be described. These soils will be sampled to a depth of 24 inches or to bedrock, whichever comes first.

Representative samples collected from the soils field sampling program will be measured for background radioactivity using standard scintillation techniques. Depending upon the alpha and beta level detected, analysis of natural uranium, thorium 230 and radium 226 may also be made.

Samples collected for the plant-soil relationship will be analyzed for textural classification, available plant nutrients, pH, cation exchange capacity, salinity and lime percentage. These parameters and properties will provide data which are relevant to the climatic and edaphic condition in the leased area. Selected samples will be analyzed for trace metals by element scan.

The soils study and analysis should be completed by the end of November 1975. All information gathered from this program will be included in the final DDP.

2.5.1.3 Results

The soils survey and study program outlined above will fulfill all lease requirements and associated stipulations. In addition, the soils program will define the relationships between vegetation types and soil environment to determine the suitability of these soils for future revegetation purposes. The relationships obtained will determine which of the native plants can tolerate the soil environment which is available and will aid in the determination of the proper species composition for a future revegetation community.

2.5.2 Archaeological Survey

2.5.2.1 Objectives

An archaeological survey will be performed on the leased area to determine the location of any existing areas of historic and scientific interest as specified by the oil shale lease. This study will be completed prior to the development of any of the leased areas.

2.5.2.2 Methods

Prior to the disturbance of any lands, during the exploratory portion of the environmental programs, an archaeological survey was completed. These initial surveys were conducted by Dr. Alan Olson, University of Denver, on areas such as drill pads, shallow water monitoring holes, hydrology stations, fenceline construction for vegetation exclosures, new roads and any other disturbance areas which were surveyed.

During the summer of 1975, an intensive archeological survey will be conducted on the site and surrounding areas. If significant artifacts are located, they will be removed for further study.

An inventory will be made to identify cultural resources that may qualify for the National Register of Historic Places. This inventory would identify the prehistoric and historic sites on the leased area and surrounding areas, and would include collections, descriptions and identification of any area which produced cultural material. These collections and records would be stored and made available to any interested parties.

A literature survey will be performed which will include an examination of collections which are pertinent to the leased area. This would include any prior archaeological studies of the area. All information will be abstracted and collated to correlate this with field information in order to provide a complete study of the cultural sites of the leased area and surrounding planned disposal areas.

The archaeological contractor will report the results of his survey to Rio Blanco Oil Shale Project.

The overall results and findings of this program will be included in the Detailed Development Plan. The archaeological survey will begin in June of 1975 and will be completed sometime during September 1975.

2.5.2.3 Results

Field surveys of disturbed areas have been completed except for the deep and shallow water monitoring stations and hydrology stations planned for the 84 Mesa area in the future.

No significant archaeological finds were made during these surveys.

2.5.3 Revegetation

2.5.3.1 Objectives

In accordance with good rehabilitation practices, to meet the lease stipulations, and as an obligation to mitigate environmental impacts due to mining and processing operations, all portions of lands which have been disturbed by these operations will be revegetated. This includes the temporary revegetation of processed oil shale, overburden and topsoil stockpiles; and the establishment of a stable ecosystem on the spent shale-overburden-topsoil rehabilitation sites and the sites with

minor surface disturbances (e.g., corehole pads and access roads).

The revegetation research program must address and provide answers to engineering problems directly related to the disposal of spent shale which will allow Rio Blanco to take the necessary steps to develop a viable rehabilitation program.

2.5.3.2 Methods

In the development of a revegetation program of this magnitude, historical information must be obtained through a literature review and search. Prior to the initiation of the Tract C-a studies, abstracts and periodicals obtained must be accumulated stored, abstracted and summarized to identify experimental designs which have been successfully used in revegetation studies. Areas where additional field and laboratory experimental studies must be performed will be defined. Through literature review, feasibility of certain revegetation programs and qualified investigators can be identified. Prior established field sites will be visited, inspected, and evaluated. The studies in this revegetation program will be directly related to the mining and processing methods used in the Tract C-a operation, and the effects of local geology, climatology and revegetation.

During the late spring and summer of 1975, various types of revegetation studies will be initiated on Tract C-a. Some of the revegetation studies presently under consideration are:

1) The seeding of disturbed areas, such as corehole pads, with mixtures of native and exotic grasses, and other corehole pads with mixtures of grasses, native forbs and shrubs. This seeding will be accomplished after the area has been reshaped.

The purpose of these and other studies is to determine procedures and methods which may be used in the future for revegetation of areas with minor surface disturbances. These studies may identify various seeds which will germinate and grow under natural conditions, without additional water and utilizing native topsoil as a growing medium. Other studies will determine the water requirements of these plants through water amendment plots established on the corehole pads. Some of the pads will be mulched after seeding to assess the benefits of mulch covers on seed germination and establishment, and erosion control in this area.

2) The many sites within the area of the leased tract which have been subjected to various types of disturbances in the past years will be studied. These disturbed sites (e.g., air strips, drill pads, old roads, pipeline corridors) may offer an immediate view of the natural sequence of revegetation, through comparison of species composition on sites disturbed at different times. Estimates of the time necessary for different stages of succession on various soil types can be made from these comparisons. This information will be useful in evaluating revegetation programs for this region.

3) Spent shale from different retorting methods will be used for the study of temporary revegetation of spent shale piles to determine the effects of underlying spent shale on the germination and growth of native and exotic plants in overburden. A portion of this study will be carried out in the laboratory.

2.5.3.3 Results

The results from literature surveys, site inspections, and experimental plots should answer the following questions:

1) What are the effects of wind and water erosion on spent shale overburden and topsoil?

2) What is the quantity and quality of water required for revegetation and how long will it have to be applied for successful establishment of plants?

3) How much overburden and topsoil is available? What are their physical and chemical characteristics? What are the optimal mixtures for successful plant establishment?

4) What is the amount and depth of leaching of spent shale and the effect of leachates on ground water? What are the tendencies of spent shale salts to move to the surface and their effects on the vegetation?

5) What are the effects of soil disruption on soil flora and fauna? What procedures need to be implemented to re-establish the soil system prior to, or concurrent with, revegetation activities?

6) What is the plant species composition of the proposed revegetation community? What plant species should be used for the temporary stabilization of the stockpiles?

7) What is the best configuration (degrees of slope, aspect, terracing, water collection areas, etc.) for the spent shale disposal site to assure successful revegetation?

8) What are the effects of mulches, fertilizers and water amendment on seed germination and seedling establishment?

9) Are there alternative methods for establishing native perennials which are more rapid than growing from seeds? Which native perennials are conducive to revegetation propagation?

Other questions will arise as this revegetation program progresses. The flexibility built into the program allows for emphasis to be shifted to new and important questions which need immediate attention. Results from the revegetation research program will be incorporated into the overall engineering and rehabilitation plans and will be outlined as a preliminary revegetation program in the Detailed Development Plan.

2.5.4 Toxicology

2.5.4.1 Objectives

An animal testing program will be performed to evaluate the environmental health effects of an oil shale industry and to obtain data which would form the basis for a sound industrial hygiene program. The proposed plan of evaluation is designed to meet Rio Blanco Oil Shale Project's most immediate needs of defining toxicity problems, primarily as they relate to man.

Materials related to both the Tosco II and the Paraho processes will be evaluated. Raw oil shale, raw organic matter (kerogen plus extractables), spent shale (TOSCO II and Paraho), total shale oil (TOSCO II and Paraho), and water extract of spent shale will be included in the tests.

2.5.4.2 Methods

(a)	Toxicology Screen	- acute oral and inhalation (rats). - acute dermal and eye (rabbits).
(b)	Subacute toxicity	- two-week dermal test in rabbits. - four-week inhalation -- 2 species (rats and monkeys); one concentration.
(c)	Sensitization	- Human patch tests for allergic contact dermatitis photosensitization.

(d) Chronic toxicity
- lifetime skin painting in mice - groups of 50 animals including positive and negative controls.
- two-year inhalation (3 test levels, rats and monkeys, dust exposure, evaluations to include clinical chemistry, respiratory physiology, pathology, chemical analyses of tissues and chamber dust sampling.)

(e) 90-day feeding water extract of spent shale
- 3 levels --rats and dogs.

2.5.4.3 Results

The toxicity testing program will begin within a few months. Some test results will be available within a few months after start-up. The more significant tests (e.g., carcinogenicity by skin painting and inhalation toxicity) require 80 weeks and 2 years respectively.

2.5.5 Trace metals

Trace metal analysis will be performed on a step-wise basis. Soils will be analyzed for trace metals. If any are found in sufficient quantities, then plants will be analyzed. If sufficient amounts are found in plants, then a first-level herbivore will be analyzed and so forth.

Appendix A

INTRODUCTION TO APPENDIX A

Morrison-Knudsen Company, Inc. was selected in December, 1974 to complete a detailed engineering study of the development of Federal Tract C-a using known technology. M-K obtained the services of Foster Wheeler Energy Corporation as its major subcontractor to study the retorting and upgrading facilities. In broad terms, this engineering study will encompass all phases of developing a major oil shale mine and processing plant and the necessary ancillary facilities for a nominal plant output rate of approximately 50,000 BPSD of synthetic crude oil. The study is being performed to the requirements of Rio Blanco and will serve two major purposes: (a) it will provide data for inclusion in the Detailed Development Plan to be submitted to the Area Oil Shale Supervisor; and (b) it will examine the technical and economic viability of the project. M-K and Foster Wheeler are cognizant of the high level of emphasis this study must place on the environmental impact of this planned facility as well as the need for a technically and economically sound design which stresses maximum economic resource recovery.

M-K divided the work into five major work areas involved in developing Tract C-a. These divisions are:

1. Mining
2. Crushing and Materials Handling
3. Processing
4. Offsites
5. Environmental Control Plan

The study by M-K and Foster Wheeler is scheduled to be completed by December 31, 1975 (approximately 13 months in duration). During the first half of the study, different alternative methods for each task will be evaluated. About mid-1975, M-K and Foster Wheeler will submit an interim report which will present results of the evaluation and will recommend such major items as methods of mining, crushing and conveying, retorting and upgrading schemes. Reasons for the recommendations and documentation for abandoned alternatives will be given. Based on this interim report, major components of the final plant designs will be selected by RBOSP.

During the second half of the study period, the contractor will make sufficiently detailed designs for meeting Detailed Development Plan requirements and for evaluating the economic viability of the project.

In addition to the M-K study, a work task concerning interim roads and support facilities for the exploration phase has been added to the Offsites project. This program is currently being accomplished under direction of the Rio Blanco Oil Shale Project.

The Utilities Acquisition Project deals with obtaining water, electricity and communication services required for development of Tract C-a and is also being accomplished under RBOSP direction.

The last major subproject shown on the Work Breakdown Structure Chart (in the introduction of this summary report) is the System Integration Project. Although not explained in further detail in this appendix section, these are the tasks that are necessary for planning, scheduling and controlling the project. Also included under this heading are activities to support all the major subprojects.

A3.0 MINING PROJECT

The Mining Project is divided into four areas. Two areas, Computer Applications and Geology and Geotechnical, are largely technical support areas. The Surface and Underground Mining areas include the actual designs and feasibility studies. The four areas and their associated activities will be reviewed briefly.

A3.1 Computer Applications to Mine Study

A computer mine modeling system having the capability of examining open pit mining alternatives will be developed. This system will consist of a series of programs which use the drill hole data and geologic interpretations to develop a prime mineral inventory of the property. The prime mineral inventory will generate the oil shale reserves, grade distribution, thickness and material volumetrics for the deposit. From this prime mineral inventory, the computer will develop working mineral inventories based on operational bench and room height parameters for the various open pit and underground mine designs. Additional programs will be used to establish the optimum mining plan for development of Tract C-a based on such parameters as maximum resource recovery, economics, early return on investment, early development, etc. This mining plan will include mine designs for 5, 10, 15, 20 and 30 years and the ultimate mine design for the total recoverable reserves of Tract C-a.

A3.2 Surface Mining

The surface mining study will include a study of alternatives, such as ripping versus blasting, front-end loaders versus shovels, sizing and selection of equipment and drilling and blasting practice. This study will determine the appropriate final and working slopes, haulage road widths and profiles, mining bench heights and mining sequences. A determination

of capital and operating costs will be developed for the mining operation.

The most suitable preliminary development sites will be selected based on the results of this study and considerations of economic, environmental and regulatory factors.

A3.3 Underground Mining

The underground room-and-pillar mining study will progress concurrently with the open pit mining study. The room-and-pillar mining will be studied with regard to maximum resource recovery, room heights, mining sequences, early development, maximum return on investment and single- versus multiple-level mining.

Engineering evaluations based on a nominal plant output of approximately 50,000 BPSD of synthetic crude oil will investigate slope versus shaft access, equipment sizing and selection, mining level development and orientation, and ventilation methods.

A3.4 Geology and Geotechnical

A thorough program of testing and data analysis will be developed to insure that necessary geological and geomechanical data for the mine design is gathered. Included in this program are tests which will provide the compressive, tensile and shear strengths, modulus of rupture and elastic properties of each rock type in the deposit. Defect analyses of rock core samples will aid in determining the strength parameters of various joint surfaces.

The output of this testing program will provide the engineers with the acceptable design criteria for open pit slopes, room-and-pillar sizes and roof span thickness. The test values will also be related to oil shale grades. Analyses and historical empirical data, available within the industry, will be used to check each phase of mine design being studied.

A computerized ground water model is available and data from previous studies of the Piceance Basin and pumping tests by other Rio Blanco subcontractors will be used to determine ground water flow characteristics near Tract C-a. Ground water transmissivities will be determined and the salinity and chemical content of the water will be analyzed. The major aquifer zones are being determined, and dewatering models are being developed.

A4.0 CRUSHING AND MATERIALS HANDLING PROJECT

This major area of work has been divided into four categories: Overburden and Waste Disposal, Primary Crushing and Plant Feed, Secondary Crushing and Plant Feed, and Spent Shale Disposal.

A4.1 Overburden and Waste Disposal

The optimum method of transporting overburden and waste to a disposal site and actual placement of the material from an open pit operation will be determined based on tonnage rates and material characteristics. Transportation methods to be studied include truck haulage, belt conveyor systems and slurry pipeline transport.

Alternative disposal sites will be evaluated based on environmental and economic factors and routes and profiles will be developed for transporting and emplacing the overburden and waste at the sites.

A4.2 Primary Crushing and Plant Feed

The first size reduction of mined oil shale and transportation of crushed shale to the primary stockpile will include the evaluation and selection of equipment, conceptual design of facilities and comparison of viable alternatives. Mine production rates will be determined for open pit and underground mines. Then ore blending requirements, location and type of crushing units, reliability, material characteristics, product specifications, and capital and operating costs will be determined.

Crushing technology from various sources will be reviewed. These will include the Anvil Points Research Center, The Oil Shale Corporation (TOSCO) and equipment vendors and manufacturers. Run-of-Mine (ROM) oil shale characteristics and production rates will be used to rate and select the primary crusher and the handling and transporting equipment.

The size, configuration and location of the primary stockpile will be considered as well as alternatives for stacking and blending of material and equipment requirements.

A4.3 Secondary Crushing and Plant Feed Preparation

The selection of equipment and conceptual design of facilities to handle primary crushed oil shale from the first stockpile, to make further size reductions for retort feed requirements and to

store adequate quantities of feed is included within the scope of this work.

Work will include the collection, review and correlation of historical crushing and screening data including information such as crusher type, capacity type and product sieve analysis, screening efficiencies and procedures. The capabilities and limitations of the equipment tested will be evaluated from results of the above studies.

A4.4 Spent Shale Dispoal

The transportation of spent oil shale from the retorts to the disposal area and the emplacement of this material is included in this work. Such tasks as the determination of physical characteristics, methods to handle, transport and compact locations for viable disposal sites and methods used for contouring and revegetating the spoil areas will be studied.

Much of the work in this area will be in conjunction with work relating to disposal of overburden and waste since methods of transportation, route alignments to disposal sites and means of emplacement will be duplicated. Truck, conveyor and slurry pipeline transport of this material to various disposal sites will be considered.

Rio Blanco Oil Shale Project has done preliminary evaluations and trade-off-studies concerning disposal sites for spent shale, waste and overburden. A letter (copy attached as Figure A-1) to Mr. Dale Andrus, State Director of the BLM, Denver, Colorado explains the thinking behind the request for natural resources land and includes the pros and cons of using various alternative locations. Figure A-2 shows the general location of each site considered with relation to Tract C-a.

As mentioned throughout Section A4.0, M-K will perform detailed engineering, economic and environmental studies to pick a best site for spent shale, overburden and waste disposal.

A5.0 PROCESSING PROJECT

The processing area of the proposed oil shale plant includes facilities to produce a nominal 50,000 BPSD of synthetic crude oil and to remove sulfur, ammonia and coke byproducts. The processing area consists of two main sections: Retorting and Upgrading.

Sized oil shale is heated in retort facilities to produce raw shale oil together with light hydrocarbon gases and spent shale. Spent shale is moistured for disposal in the spent

FIGURE A-1

LETTER TO BLM REGARDING
OFF-TRACT DISPOSAL AREAS

Gulf Mineral Resources Co.
A Division of Gulf Oil Corporation
Standard Oil Company (Indiana)

Dayton Commons
9725 East Hampden Avenue
Denver, Colorado 80231
303-751-2030

Rio Blanco Oil Shale Project

February 13, 1975

Mr. Dale Andrus
State Director of BLM
Denver, Colorado

Dear Mr. Andrus:

Thank you for your letter of February 5, 1975, acknowledging receipt of our request for natural resource lands for spent shale and overburden disposal as well as various necessary facilities. To further explain the thinking behind our request for approximately 4959.40 acres, we would like to review some factors which we believe are important considerations. Also, we would like to set forth the pros and cons of using various alternative locations as we see them.

A significant part of our decision to invest in the leasing of Tract C-a was the clear-cut intent of the prototype oil shale program to study the economic and environmental feasibility of open pit mining on this particular parcel of land. To us, this approach makes a great deal of sense. No one can be sure of the results until the various methods are tried, since an industry of this type has never existed in the United States.

Further, the balancing of energy needs with environmental safeguards has had few opportunities to be tested to the degree called for in the oil shale program. Achievement of these multiple goals appears to require the developments anticipated by the prototype program. We feel our decision to request the 84 Mesa Area is commensurate with these objectives.

First of all, given the goals of the prototype program, disposal of waste on the tract itself would surely hamper future open-pit mining of part of the resource as well as adding to the cost. The final environmental impact statement prepared by the Department of Interior recognizes the strong likelihood of off-tract disposal for optimum development. The following statement appears on page 13 Chapter III, Volume 1.

"During the early years of an open-pit development, permanent disposal of overburden would be off-site. After 10 to 20 years of full-scale production it would be possible to begin disposing of part of the overburden and processed shale into mined-out portions of the pit." We agree with this statement and our engineering and mining studies are focused on quantifying this strategy.

Volume 3, Chapter IV of the statement contains about 2 1/2 pages and four drawings which refer to Tract C-a off-site spent shale and overburden disposal. We had reviewed the options described in the EIS plus several other

alternatives prior to our letter of December 20, 1974. We would like to set forth the major considerations which provided the rationale for that letter. The following is a list of advantages and disadvantages of various off-site disposal locations.

STAKE SPRINGS DRAW

(Area has approximately 1,680 acres of patended land - State and private)

Pro:

1. Located adjacent to Tract C-a, and would thereby minimize the area subjected to environmental impact.
2. Cost of moving spent shale from tract to disposal area would be relatively low.
3. Capacity for holding waste is relatively good.
4. No exceptional scenic values.
5. Limited to one drainage area.
6. Minor visual impact.
7. Lower reclamation costs.

Con:

1. Overlies oil shale reserves recoverable by open pit methods.
2. Lies downstream of a large water shed, in a major drainage; erosion, flooding and water pollution are potentially significant problems.
3. Would cover Stake Springs, major water source for livestock and wild life.
4. Covers large area of meadow land and relatively good valley bottom land.

WEST FORK, SPRING CREEK

(Area has approximately 1,100 acres of patented private land)

Pro:

1. No mineable reserves covered by spent shale disposal.
2. Relatively good capacity for receiving spent shale and other waste.
3. Located on headwaters of single drainage.
4. Minimal erosion problems.
5. Relatively easy to reclaim
6. Little or no usage by feral horses.
7. Little visual impact as area is relatively well hidden.

8. Relatively good protection from wind should minimize fugitive dust problems.

9. Relatively small area impacted in comparison to waste capacity, due to depth of canyon to be filled.

Con:

1. Good to excellent grazing for livestock.

2. Good to excellent wildlife summer range.

3. Some damage to otherwise unimpacted water shed.

4. Potential nesting area for raptors.

5. Would enlarge environmental impact, due to extensive conveyor belt system carrying spent shale and other waste from mine to disposal area.

6. Very scenic area.

7. Potential for archeological values.

8. Extremely high cost to public and company involved in moving shale and other waste an additional distance of approximately 5 miles compared to 84 Mesa.

9. Impacting more than one ecosystem.

10. Area contains heavy spruce stands.

WEST AND NORTHWEST OF TRACT

(Area has approximately 640 acres of patented state land - remainder is Federal public domain subject to unpatented oil shale mineral claims)

Pro:

1. Adjacent to tract, resulting in reduced geographic area to be environmentally impacted.

2. Same basic ecosystem as on Tract C-a.

3. Relatively low negative visual impact.

4. Relatively poor scenic value.

5. Relatively low grazing value for livestock or big game.

Con:

1. Relatively shallow overburden covering oil shale reserves recoverable by open pit methods.

2. Title to large portion of this land is in conflict (with Ertl claims).

3. Poor capacity to receive significant amounts of waste from C-a.

4. Area located near headwaters of several drainages in a large catchment basin with a potential for erosion, flooding and water pollution.

5. Waste would cover several seepage springs.

6. Summer range for feral horses.

7. More costly due to added lift of about 600 feet, compared to 84 Mesa.

DOUGLAS CREEK

(All land is Public domain)

Pro:

1. No mineable reserves of oil shale in the area.

2. Poor grazing for large game animals and livestock.

3. Revegetation would be difficult, but in all probability would improve present carrying capacity.

Con:

1. Poor capacity to hold necessary amounts of spent shale and waste.

2. Would affect multiple water drainage systems not otherwise impacted by project.

3. Would enlarge environmental impact due to an additional 7 miles of conveyor corridors, compared to 84 Mesa.

4. Would impact several ecosystems including unique area of Cathedral Bluffs.

5. Potential raptor nesting area.

6. High visual impact; next to Douglas Pass Highway.

7. Poor economic choice for both public and lessee, due to substantially increased expense of moving spent shale and other waste long distances and down steep fact of Cathedral Bluffs.

8. Area located near headwaters of several drainages in a large Catchment basin with a potential for erosion, flooding and water pollution.

84 MESA

(Area has approximately 440 acres of patented-state land)

Pro:

1. Near Tract C-a, thereby reducing area impacted.

2. Oil shale reserves to be covered are not likely mineable by open pit methods.

3. Area is of marginal value as big game habitat.

4. No exceptional scenic values.

5. Apparently least costly to public and lessee.

6. Area is not believed to contain any particularly valuable or unique floral species.

7. Area would receive no water from major established drainages which minimizes potential for erosion, flooding and water pollution.

8. Same ecosystem as C-a.

Con: 1. Wide visual impact; however could be contoured and disguised effectively.

2. Relatively greater exposure to wind which could result in increased fugitive dust problems.

3. Area used at times by feral horses.

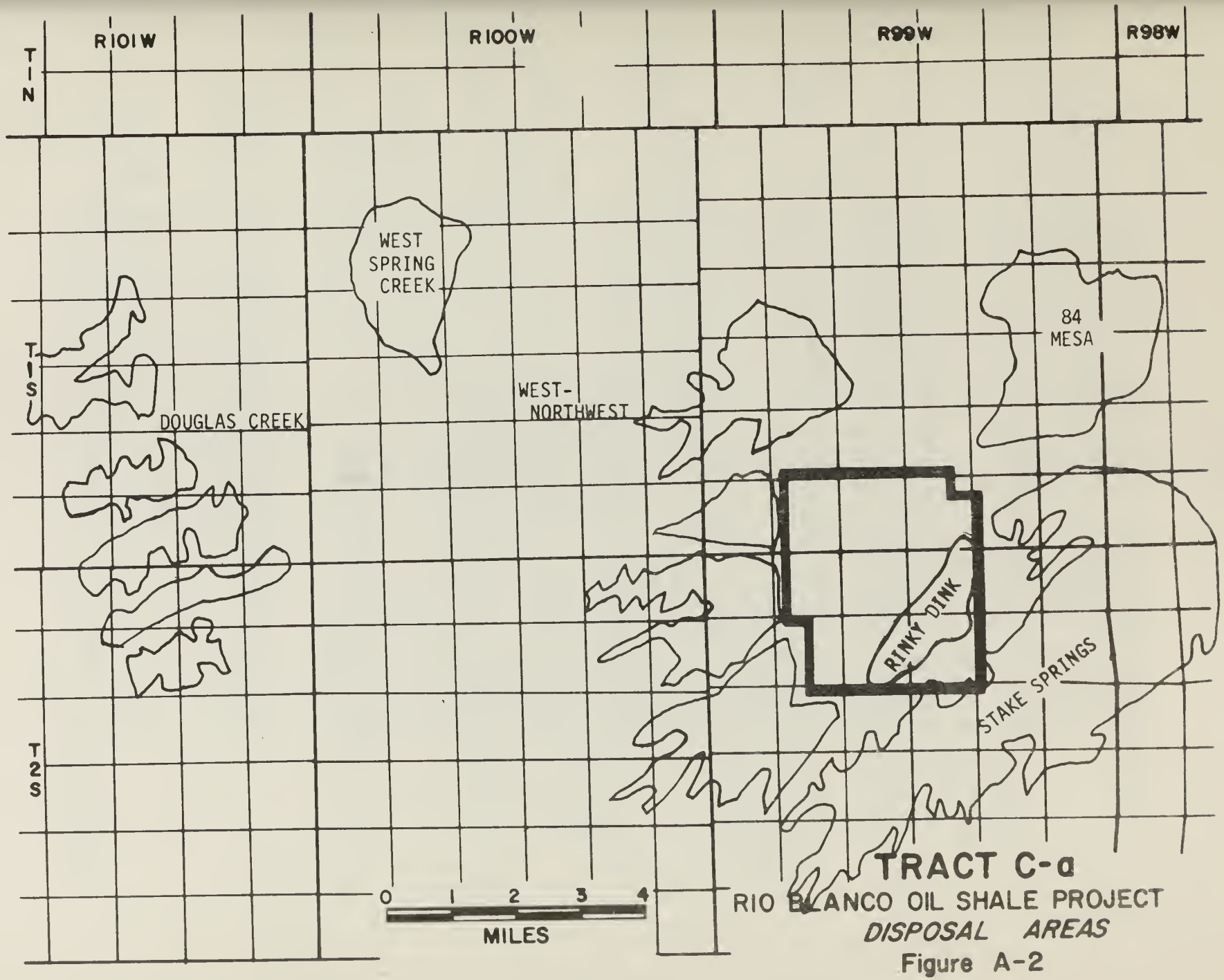
We hope this review of the alternative locations, along with the attached map, will be of help to you in your analysis. We would like to sit down with you at your earliest convenience and discuss the matter. We very much appreciate your cooperative attitude in dealing with our request in an objective way.

Yours very truly,

W. T. Herget

WTH:jp

cc: Mr. Peter Rutledge



TRACT C-a

RIO BLANCO OIL SHALE PROJECT

DISPOSAL AREAS

Figure A-2

shale disposal area. Raw shale oil is processed to remove sulfur, nitrogen, and oxygen compounds to produce a synthetic crude oil suitable for off-tract refining into marketable petroleum products. Sulfur, ammonia and coke byproducts are recovered in the Upgrading section, and light gases are cleansed for use as fuel in the plant.

A5.1 Retorting

Engineering studies of the processing area of the proposed oil shale plant are comprised of an evaluation phase and the process design phase. The evaluation phase of the study includes a technical and economical assessment of single modules with two types of oil shale retorting systems -- a Gas Combustion Retort Process, and the TOSCO II Process. A major parameter in the module study is the grade of oil shale charged to each retort.

The Gas Combustion Retort was originally proposed by the Bureau of Mines and was extensively tested in pilot plant retorts at Anvil Points by both government and private industry. Development work at Anvil Points indicates that the principles of the Gas Combustion Retort can be successfully scaled up to a commercial-size retort system.

During early 1975, a preliminary design for a 6,000 TPD Gas Combustion Retort module will be developed, including retorting system, oil collection system, and gas cleaning system. Estimates of capital investment and utility requirements will be worked up, and study of details of the design will continue.

The TOSCO II process is a proprietary process of The Oil Shale Corporation. Designs for an 11,000 TPD TOSCO II retorting module with various shale grades will be started. Heat and material balances for the various shale grades will be worked up, together with flowsheets and equipment specifications.

The evaluation phase results will be used to select the type and combination of retorts for further study. The nominal 50,000 BPSD plant will be evaluated technically and economically for various shale grades.

Evaluation of alternatives for the nominal 50,000 BPSD processing plant together with studies of mining activities, will be used to select a processing plan for design and and presentation in the Detailed Development Plan. Process

design of the synthetic processing plant constitutes the second phase of the process engineering study.

A5.2 Upgrading

The first step in the upgrading sequence presently visualized for the Rio Blanco Oil Shale Project is the separation of retort hydrocarbons into gas, naphtha, gas oil, and residual fractions. A portion of the residual oil is charged to a delayed coking plant where coker distillate and coke are produced. Coker gas oil and retort gas oil are hydrotreated to remove sulfur and nitrogen compounds. Coker naphtha and retort naphtha are treated in a second hydrotreating unit.

Gas from retorting, coking and hydrotreating is collected, separated, and then purified in a gas plant to produce C_3 and lighter fuel gas and butanes. Hydrotreated gas oil, naphtha, and butanes are combined to produce a synthetic crude product. Facilities for separating elemental sulfur and ammonia are included in the upgrading sequence in addition to sour water stripping systems.

During early 1975, preliminary overall material balances will be prepared for the upgrading section and design work will be started on the hydrogen, hydrotreating and delayed coking plants. Work will be started on the remaining units when all products from the major units are more completely defined.

Alternative studies are planned to investigate the possibility of reducing or eliminating production of coke, which is likely to be of low quality because of high ash content. Reducing the coke production would improve the syncrude yield.

A6.0 OFFSITES PROJECT

The offsites studies include the following six areas which are non-mining and non-processing in nature:

1. Process Water Supply Development
2. Corridor, Areal and Site Selection
3. Transportation Development
4. Utilities and Communication
5. Support Facilities
6. Interim Roads and Support Facilities

A6.1 Process Water Supply Development

The water supply development studies will include preliminary functional engineering, planning and design, and estimates for

the storage, conveyance and distribution facilities necessary to provide Tract C-a with an estimated 60,000 acre feet per year water supply which may be required for ultimate project development. The initial plant of 50,000 BPSD will require only about 10,000 acre feet per year. The initial supply system will be designed so it can be built in stages if the development is later expanded. Both surface and ground water supplies will be considered. The studies will include (1) treatment works as required for processing and potable supplies and disposal of wastewater from processing, mining and domestic operations, and (2) dewatering facilities including sanitary sewer collection systems, storm drainage and flood protection structures.

Pursuant to the conditional storage decree granted July, 1974 (Division 5 Water Court Case No. W-2221) for the Yellow Creek dam and reservoir, the following studies concerning the Yellow Creek Dam will be made: probable maximum flood analysis, dam axis location, reservoir elevation-capacity curve computation, elevation-dam embankment curve computation, spillway design, flood routing, outlet works layout and sizing, sedimentation estimates, reservoir sizing, preliminary embankment design and drainage area calculations. Geologic and hydrologic investigations essential to these studies will be performed.

Alternate studies for a supply system for the delivery of water to the Yellow Creek Dam will be done. Also, to be studied is the water distribution system to the process plant.

A6.2 Corridor, Areal and Site Selection

The Corridor, Areal and Site Selection program includes preparation of a reliable land use plan for Tract C-a and surrounding areas. Preliminary studies include origin-destination studies for products, goods and services, as well as labor and plant works considering the differing requirements during construction and operational phases of the project. Land use plan alternatives will be refined and periodically revised until the mining plan is firm and processing and offsites facility locations can be fixed.

Multiple-use corridor plans for Tract C-a will be integrated with BLM corridor studies.

The corridor studies will concern themselves with alternative locations for oil shale developments (plant sites, spent shale disposal areas, water supply needs) on the tract and adjacent nearby lands. Specific initial land allocation considerations will include: anticipated extent of land desired, proximity

to initial mine areas, proximity to spent shale and waste disposal areas, avoidance of potentially recoverable ore, access to water and power supplies and consideration of pipeline transmission facilities. These locations will be evaluated with respect to physical and environmental constraints and in context with corridor, social, economic and engineering feasibilities.

A6.3 Transportation Development

The Transportation Development studies will include preliminary engineering, planning and designs and estimates for the planned development of area transportation systems to serve Tract C-a. The studies will comprise the following:

A. Review of existing transportation system and planned development of the system by local, state, Federal and private groups;

B. Forecasts of the movement of people, goods, and products;

C. Investigations of alternative modes, together with their respective alternative details for the movement of people, goods and products;

D. Selection of an optimum transportation system that will minimize damage to the environment and preferably utilize a single transportation corridor.

A6.4 Utilities and Communications

The Utilities and Communications Development studies will include preliminary engineering, planning, designs, and estimates for electric power, communications, and fuels distribution systems needed to build and operate the project.

The environmental impacts will be evaluated and methods of mitigating these impacts are being considered as estimates are formulated.

Power and other utility needs will be quantified to enable contracting with power suppliers and public communication enterprises. Planning and studies will include consideration of power, communications and fuels for mining, retorting, upgrading, disposal/reclamation, water supply facilities, transportation and other support facilities.

The fuel requirements such as diesel, gasoline, natural gas, liquified petroleum gas, etc. and its storage requirements will be determined.

A6.5 Support Facilities

The Support Facilities Development studies include preliminary engineering, planning, designs and estimates of miscellaneous buildings, structures and other facilities necessary for the construction and operation of the project. These facilities will be in support of the mining and processing operations.

A6.6 Interim Support Roads and Facilities

The Interim Support Roads and Facilities Program consists of those activities to be conducted per Section 10 (and amendments thereto) of the Exploratory Plan for Federal Tract C-a. The activities under this program pertain to siting, constructing, and maintaining temporary access roads (both on-tract and off-tract); secondary electrical power lines (to supply power to baseline data monitoring and gauging stations and other structures); field offices, first-aid stations; sanitary and refuse disposal facilities; basic communications systems; and other incidental structures (culverts, cattleguards, fencing, signs, etc.) required for the interim period preceeding development of the lease tract and related offsite improvements.

This discussion is limited to reporting significant actions taken (or proposed) that modify the initial program set forth under the Exploratory Plan.

In accordance with the Exploratory Plan, Rio Blanco Oil Shale Project processed the required special land use permits (SLUPS) with BLM for construction of the then planned temporary offsite access roads as shown on Enclosure No. 4 (Map) of the Exploratory Plan. These temporary road improvements were not made because of the difficulty of maintenance and snow removal over the routes and the travel-time distance involved.

Formal request was made to the Area Oil Shale Supervisor on February 18, 1975 to eliminate the temporary access provisions of Section 10 of the Exploratory Plan in favor of providing access by a single route traversing Rio Blanco County Road No. 24. This county road, also known as Ryan Gulch Road, connects with the Piceance Creek Road and has served as the safest, shortest and most convenient access to Tract C-a.

The request for utilization of County Road 24 proposes that incidental grading, widening, straightening and rock surfacing be done along portions of the access route to provide a facility that will be safe for the expected traffic volumes and will result in less maintenance. The improvements sought will reduce the problems of fugitive dust and the expense of

sprinkling to retard the dust. Some widening and straightening will be necessary for reasons of safety.

Pending approval by the Area Oil Shale Supervisor, the BLM and the Colorado Division of Wildlife, surveys will be made to develop plans for improving County Road 24. It will be necessary to determine the best road alignment to minimize potential environmental effects.

Special land use permits essential to the surveying and road improvement construction will be obtained from BLM. Archaeological clearances will be obtained. Actual surveying and road construction will be performed by the County under the necessary specifications and environmental stipulations. Materials for surfacing will be obtained from "pit sources" approved by BLM and the Area Oil Shale Supervisor.

After the proposed road improvements are satisfactorily completed, RBOSP will continue to assume responsibility for snow clearing those parts of existing road they now maintain. Approximately 5.5 miles of the existing 13 mile route from the Piceance Creek Road to Tract C-a is snow cleared by the County. The remainder is maintained by RBOSP along with other on-tract roads and trails to baseline data gathering stations. Other general maintenance of the improved road will remain in the purview of the County.

With respect to providing secondary electrical power lines to assorted baseline data facilities, etc. the installation of nearly all required 7.5 kv lines have been completed. Surveys, clearances, rights-of-way, permits, and construction were performed by Moon Lake Electric Association and the White River Electric Association.

A request to extend (some three-quarters of a mile) a White River Electric Association power line presently terminating due east of the northeast corner of Tract C-a to the northeast tract boundary has been placed with the BLM and the Area Oil Shale Supervisor. This extension is to serve the U.S.G.S. surface water gauging station located in "Rinky Dink Gulch" and provide power to the resited (discussed below) first-aid station in the northeast corner of Tract C-a.

Because the proposed and present access to the tract is at the northeast corner, it was decided to relocate the first-aid station to the northeast corner from its previous location per the Exploratory Plan. Resiting and rehabilitation of the former site was approved by the Area Oil Shale Supervisor and that work has been completed.

Interim communications needs are being satisfied by use of VHF radio repeater system installed at the tract.

Plans for extending conventional telephone service communications lines cross-country to the tract as set forth in the Exploratory Plan have been curtailed. Until Mountain Bell Telephone Company's existing facilities in the entire region are expanded, it appears that the accessibility of telephone service and construction of telephone lines to the tract will be delayed indefinitely.

A7.0 ENVIRONMENTAL PLAN PROJECT

It is recognized that one of the prime concerns of this project is the preparation of the Detailed Development Plan, which will emphasize the environmental impacts and mitigative alternatives of the project in the context of technical and economic viability. The environmental section of this project will compare the engineering design against the baseline environmental data to assess impacts. It will insure that the plans developed are in compliance with all applicable state and Federal requirements. The environmental section has been subdivided into five areas: Safety and Health, Atmospheric, Reclamation, Hydrologic, and Environmental Master Control Plan.

A7.1 Safety and Health

These activities will mainly be in the areas of obtaining and establishing hazard control in the following areas: noise level, dust control, equipment standards and safeguards, fire prevention requirements, hazard control and recommended guarding of crushing and ore processing operations and electrical requirements for mining. Special attention is being given to the Federal Health and Safety Standards for Metal and Nonmettalic Mines Laws (Title 30, Parts 55, 56 and 57) and the Colorado Mining Laws (Bulletin 20).

A7.2 Atmospheric

Studies will be made to determine the Federal Air Pollution Laws and the Colorado State Air Pollution requirements and others as they will apply to Federal Tract C-a. Dispersion models and monitoring requirements will be developed using inputs from Rio Blanco Oil Shale Project and its contractors. The requirements for retorting and upgrading facilities will help in plant site selection and air quality control. Coordination will be established between the Offsites, Mining, Crushing and Processing groups to insure that designs and specifications are made that will eliminate or mitigate the

pollutants emitted. It is recognized that the mining and crushing and materials handling areas will have specific air pollution problems. Efforts are to be directed towards optimization of the most economical and effective dust suppression methods for each specific application.

A7.3 Rehabilitation

The techniques and plans to rehabilitate Tract Ca, and any off-tract disturbed areas, to meet all governmental reclamation rules and regulations will be developed. The rehabilitation plan will cover facilities such as roads, power transmission lines, water lines, plant site, mining and disposal areas.

Literature searches will be conducted to include all applicable information including: spent shale physical characteristics, revegetation possibilities and constraints, basic rehabilitation concepts, water control problems which will be posed by dumping spent shale and road and plant site construction. Environmental design concepts for rehabilitation compatible with engineering data and economics will be developed, and a ranking/ratio system for environmental analysis of spent shale deposit locations, plant site locations and access corridors will also be generated.

A water balance for the surface of the spent shale spoil piles will be developed to determine necessary amounts of water for establishing vegetation.

A7.4 Hydrologic

Water supply and treatment problems affect all aspects of the development of Tract C-a. Ground water control, process water, spent shale disposal area runoff, and the wastewater reservoir will be monitored. Alternate spent shale disposal areas will be analyzed to protect them against flood waters and to collect rainfall runoff that occurs on these spent shale piles. Runoff quantities using data based on the longest period of reliable information, will be calculated along with systems of ditches, pipelines and pumping stations which will be sized to collect and transport this water to the wastewater reservoir.

A7.5 Environmental Master Control Plan

The Environmental Master Control Plan will incorporate all the environmental requirements in an overall plan. The activities of the Mining, Crushing, Processing and Offsite areas will be reviewed from an environmental standpoint. Alternate solutions

to environmental problems will be analyzed to select viable options for mitigating or eliminating adverse environmental effects by using information from the environmental baseline contractors and all other RBOSP subcontractors.

A8.0 UTILITIES ACQUISITION PROJECT

The Utilities Acquisition Project includes determination of alternate means and sources to obtain, furnish, deliver and convey a needed water supply and electrical power associated with development of Tract C-a. This project also entails consideration of communications service needs.

The Utilities Acquisition Project, with respect to power and communications, is concerned with obtaining service from public utility companies. It concerns supply and transmission as differentiated from distribution. Technical engineering for distribution, equipment selection, etc., is addressed under the Offsites Project.

The water supply development program is that segment of the planning having to do with investigating the availability and use of water resources from both a legal and economic point of view. This subject area includes hydrologic evaluation of ground water potential and surface runoff as well as the functional planning for dam and reservoir sites, pipelines, pumping stations, treatment facilities, etc. Engineering studies and environmental analyses of alternatives for water supply development are included in the Offsites Project.

A8.1 Water Supply Acquisition

An active program to acquire the water needed for development of the lease is being pursued by Gulf and Standard. The program for water supply is directed towards the acquisition of the lawful right to divert to beneficial use, from both groundwater and surface sources, a net annual amount of 60,000 acre-feet for an ultimate potential syncrude production level.

In December, 1974, Gulf and Standard filed an application for ground water use with the Colorado Division 5 Water Court (Case No. W2514) in order to establish a legal right to use all ground water which might be extracted in the proximity of Tract C-a. The application cites all relevant legal arguments to establishing this right, including legal arguments advanced per the controversial interpretation of the Federal "reserved rights doctrine". Pursuant to this doctrine, the rights to these groundwater resources are claimed in behalf of the Federal government as conjunctive to the oil shale withdrawal of 1930. Final disposition of these claims is expected to require a lengthy period of time in the courts.

Comprehensive ground water hydrology studies are being carried out under other program areas to determine (1) how much ground water is available in the tract vicinity and (2) what effect ground water withdrawal and use will have on other local ground water and/or surface water users.

As it is likely that groundwater will not be adequate to supply potential ultimate water demands, the program for water supply acquisition concurrently calls for investigation of possible surface water resources. It is planned that both groundwater and surface systems be developed in stages as the water use for the project increases.

In December, 1974, Gulf and Standard filed an application with the Colorado Division 5 Water Court (Case No. W2541) for a diversion on the White River. The diversion of some (nominal) 300 cubic feet per second flow from the White River to a proposed off-channel Yellow Creek Reservoir is sought. Gulf and Standard were issued a conditional storage decree for this reservoir in July, 1974 (Division 5 Water Court Case No. W-2221).

Pending more definitive results of studies in progress, Gulf and Standard have asked the BLM to defer processing an application (filed earlier) for rights-of-way pertaining to the Yellow Creek Reservoir.

The 1974 priority date sought per the Water Right Application under Case No. 2541 should allow diverting water from the White River approximately through the year 1985. After that date, it is believed that earlier priority water rights will be required. Following purchase of such earlier rights, Gulf and Standard will initiate change proceedings to convert these rights to the planned diversion point. There are no plans to convert irrigation rights to industrial use. A change in the point of diversion of other conditional rights for industrial use from upper reaches of the White River to a point on the White River about 20 miles below Meeker, Colorado is contemplated. This is seen as more beneficial environmentally than other alternatives for utilization of surface waters from remote upper reaches of the White River.

Gulf and Standard have held discussions with both the Yellow Jacket Conservancy District and the United States Bureau of Reclamation concerning a joint project which would use the aforementioned off-channel Yellow Creek Reservoir to augment the industrial portion of the Bureau's longstanding Yellow Jacket Project.

Consideration of alternate water supply resources vis a vis other Bureau of Reclamation existing or proposed projects is inherent to Gulf-Standard's assessment of potential water resources.

Assessments and comparisons of alternative water supply resources will be made. The study of these alternatives will pursue and delineate a system of minimal environmental impact at optimum cost. These (study) results accompanied by the rationale for selection of an environmentally acceptable and economically viable solution for the water supply will be amplified in subsequent reports.

Gulf and Standard have each joined CORSIM II. This acronym stands for the Colorado River Simulation Model II, which is a complex and sophisticated computerized method (developed by a group of cooperating organizations) for rapid and accurate appraisal of water resource yield reliability. Input parameters include priority, use and withdrawal records, hydrological data, historical hydraulic records, and other factors. Use of CORSIM II is a principal part of water supply resource evaluation studies in progress.

A8.2 Power Transmission

Gulf and Standard executed an agreement in September, 1974 with the Moon Lake Electric Association. The agremeent provides that Moon Lake will perform engineering, right-of-way and environmental studies necessary for a 230 KV power transmission line to serve Tract C-a.

Alternate routes for the power transmission line have been reviewed with the BLM, preceding aerial mapping and profiling the alignment.

Preliminary plans, designs and cost estimates will be prepared for the proposed transmission facilities. The preliminary plans will be accompanied by an environmental assessment pursuant to the preparation of an Environmental Impact Statement by the REA. Conclusion of the NEPA-EIS processes must precede the final engineering and construction of the transmission facilities by the Moon Lake Electric Association.

Identification of Gulf-Standard's initial and long term power needs is a task to be accomplished under appropriate parts of the engineering projects and these needs await firm definition of the mining and processing plan.

A8.3 Communications

The communications program will be directed towards arranging for trunk services with the Mountain Bell Telephone Company. This will possibly be in conjunction with other "suppliers", in the case of needs to interconnect radio or micro-wave facilities with conventional telephone communications. Commitment to any particular type of communication system is greatly dependant upon functional engineering communications studies contained in the Offsites Project.

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Progress report summ
Tract C–a oil shale

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